Reflector

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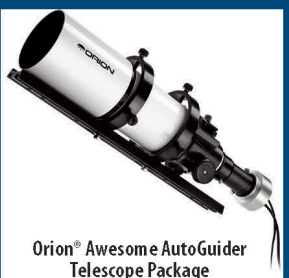

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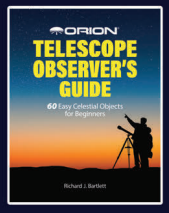

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TITLE PHOTOGRAPH: NGC 1850, THE DOUBLE CLUSTER. CREDIT: NASA, ESA, AND MARTINO ROMANIELLO (EUROPEAN SOUTHERN OBSERVATORY, GERMANY)

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This image of **Melotte 15**, captured January 25–29, 2017, was provided by **Jerry Gardner** with the **Fort Worth Astronomical Society**. He used a Sky-Watcher Esprit 150 mm and a Trius-SX694 camera on a Paramount MX+ mount. Guiding was via a Lodestar X2 off-axis quider. Sequence Generator Pro was used, total exposure was 13 hours with 10-minute subs. Processing was with PixInsight and Photoshop.

To our contributors: The copy and photo deadline for the June 2017 issue is April 1. Please send your stories and photos to our managing editor, **Ron Kramer** (*editor@astroleague.org*), by then.

The Astronomical League invites your comments regarding this magazine. How can we improve it and make it a more valuable resource for you, our members? Please respond to the editor's email address above.

Reflector

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A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION

To promote the science of astronomy
- By fostering astronomical education,
- By providing incentives for astronomical observation and research, and
- By assisting communication among amateur astronomical societies.

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Reflector

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***Reflector* and Club Roster Deadlines**

March issue	**January 1**
June issue	**April 1**
September issue	**July 1**
December issue	**October 1**

Field of View

From the office of your president

The coolness of "everything"

No doubt about it. Our avocation enjoys a high *"coolness quotient."* What other pastime allows people to see the universe as it truly is? What other hobby directly confronts matter, energy, space, and time? What other avocation deals with... well... everything? That all adds up to something exceptionally cool.

So, how do we deal with "everything?"

First, imagine what an astronomy club brings to its members.

Guest speakers at club meetings often explain esoteric topics such as planetary geology, stellar evolution, galactic morphology, and cosmology—all subjects having implications deeply affecting the emergence of life on Earth, and, ultimately, us. While the topics themselves are packed with science, most of the presentations are accomplished with only a smattering of math, making difficult concepts easier to understand. Intellectually cool.

All cool stuff. All through your Astronomical League. Pile of cool stuff amateurs have at the ready.

Club members often share their latest observing concerns such as what objects to view and how best to observe them. How can you see the Helix Nebula, both with and without a telescope? When can you spot the "Lunar X?" What magnification is best when viewing Ganymede as it slides into Jupiter's shadow? Can you really measure Beta Persei's oscillating brightness? Where is Lynx in tonight's sky? Attend a club meeting and find out. All very cool.

Like most hobbies, ours requires equipment—and we have some of the coolest around. For starters, just think of all the telescopes that amateurs regularly use: lightweight "travel" telescopes for trips across the country or ocean; specialty scopes strictly for solar observing; long-focal-length, highly color-corrected scopes for planetary and lunar studies; fast scopes for dramatic, sweeping views; large-aperture "light buckets" for capturing photons from wispy nebulae and faint galaxies; giant binocular telescopes for enhanced double vision; and astrographic scopes not even designed for visual use. Now consider all the associated accessories: star maps of any level of detail, laser pointers, finderscopes, filters, and the extensive array of eyepieces. All amazingly cool.

Incredible celestial wonders the public can see through a Library Telescope: Albireo, the Double Cluster, and M31

Second, imagine what an astronomy club brings to its community.

While interested members of the general public may not have the same sense of passion or degree of knowledge as many amateur astronomers, they do have a substantial amount of curiosity. They want to see more; they want to learn more. And they respect those amateur astronomers who share views of the heavens while taking time to explain it all in friendly, non-condescending ways.

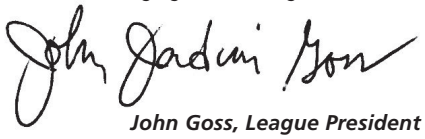
People are impressed with and somewhat intimidated by the equipment found in common use today. They are amazed at the science, but don't adequately understand it or comprehend its implications. They hear and read about black holes, dark matter, and supernovae. They see fantastic, colorful images taken by ground-based observatories and space telescopes. People want to know about the science of astronomy, the art of observing, and the gear that makes it all happen. They look to us, amateur astronomers, for guidance to make sense of "everything."

The result? Amateur astronomy is seen as being seriously cool.

Next, imagine the importance of meeting the public.

Connecting with the public is essential for our incredible hobby to continue. If folks see the stars, and understand the sky, then we will have gained allies in the fight against the senseless scourge of light pollution. Consequently, amateur astronomy will not only continue, but will continue to enjoy a high coolness quotient.

Let the Astronomical League help with keeping astronomy's coolness quotient high. Start on one of its many Observing Programs—some for beginners, others for intermediate and advanced amateurs; nominate qualified members for its recognition and youth awards; participate in its rewarding outreach programs such as Astronomy Day or the Library Telescope drawing; and submit your celestial renditions for its sponsored Sketching Observing Award and Imaging Award Programs.



John Goss, League President

TITLE PHOTOGRAPH: BIG LICK GALAXY GROUP; LYNN HILBORN; WHISTLE STOP OBSERVATORY; GRAFTON, ONTARIO, CANADA

TITLE PHOTOGRAPH: SEYFERT'S SEXTET; NASA GODDARD SPACE FLIGHT CENTER

Hello Mr. Kramer:
In the article titled "The Storms of Jupiter," the author stated, "the material in the Great Red Spot is welling up from the warm interior, making this a high-pressure area (an anticyclone, with counterclockwise rotation)."

On the Earth, whether northern or southern hemisphere, an area of high pressure is sinking air. That is why the sky is usually cloud-free. An area of rising air, like the GRS is described in the article, is an area of low pressure on the Earth. So why the different designations? Is the author in error?

Thanks,
Howard Marcus
NOVAC member

Author replies:
The Great Red Spot (GRS) is an area where the air flows outward from its core. Coriolis force causes it to swirl counterclockwise (southern hemisphere). Since gas flows outward from the GRS, it would be a high-pressure area at the GRS's altitude. There may be a low somewhere below it feeding the upwelling gas, but since there is no surface on Jupiter, we cannot determine its altitude. Like the eye of a hurricane where there is a low on top and a high on the bottom, the GRS is a high-pressure area at its altitude with a low probably somewhere below it.

I hope that makes the situation a little clearer.

Dear Mr. Kramer:
I have just received my December issue of the *Reflector*. I receive it, I assume, because I was a recipient of the Astronomical League Award. As editor of *JAAVSO* and a contributing editor of *JRASC*, I think I know a good astronomical publication when I see one. And the December issue was particularly interesting and attractive.

I enjoy the variety of content. I particularly enjoyed the article about Rollin Van Zandt, who I knew in my earlier days, and the page 22–25 summary of the League's many awards and other programs.

It's a good way for me to keep up with amateur astronomy in the U.S., and with pro-am activities. So please keep up the good work!

John R. Percy, PhD, FAAAS, FRASC
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john.percy@utoronto.ca

Radio Astronomy Observing Program

Tired of observing with just your eyes? How about looking (or listening) to the skies with an entirely different view not possible with human senses? The Radio Astronomy Observing Program has levels for observing with radio frequencies for the beginner, the initiated, and those who are exploring their capabilities in depth. Explore different methods with simple or complex equipment—it's your choice. Ham operators find this a unique way to further enjoy their hobby. Design your own equipment, buy something off the shelf, or adapt designs from others. Any way you choose, radio astronomy can be an adventure to meteors, planets, the Sun, space weather, or even our galaxy and beyond in the radio spectrum.

Dear Mr. Kramer:
There are historical dates and days that will live in infamy that we all should know by heart. One of the most significant dates in spaceflight history is the landing of Apollo 11.

I read the article by Gregory T. Shanos regarding collecting meteors. I am surprised and disappointed that the date given for the Apollo 11 landing is July 21, 1969. That error should have been obvious to any editor associated with an astronomy magazine. It should have been caught and corrected.

Siegfried Jachmann
Salt Lake Astronomical Society

Editor replies:
You are absolutely correct, and my apologies for not catching it. The correct date for the Apollo 11 landing is, of course, July 20, 1969. We run each article past two peer-reviewers plus two other editors and our executive council before I give the final blessing. It should have been noticed by all of us. I cannot explain why it was not caught, and we will print your letter as a correction in the March issue.

Thank you for pointing this out. While we strive for 100% error-free magazines, occasionally we goof. We really goofed on this one.

Ron Kramer

Dear Editor:
Thank you for publishing Dr. Shanos's article on meteorite collecting (December 2016); I can also testify as to how fascinating these fragments, samples from across space and time, can be. I'd like to add one thought, though: the reason that we know so much about meteorites is that a relatively small community of scientists have devoted time and effort into unlocking their secrets.

But, as with other natural sciences (paleontology comes to mind as a prime example), the scientific community not infrequently comes to odds with the community of private collectors. Rare specimens that get purchased by a collector (who, perhaps surprisingly, may have a larger budget than a cash-strapped scientific institution) get locked up out of reach of scientific investigation.

I volunteer at the Field Museum of Natural History in Chicago, which holds a large research collection of meteorites. I help with research investigations there, and see researchers from around the world making use of the collection. I see scores of interesting discoveries being published by these people.

Not long after I started that work, I donated most of my own meteorite collection to the museum. That made me feel like I was not collecting for myself, but for scientific advancement. I'm not suggesting that amateurs shouldn't collect, but that perhaps when we do, we should place an ultimate goal for our collection "habit;" perhaps just making sure that when we pass away (or lose interest), our collections pass on, intact, to some scientific institution—where, I have no doubt, they will be most welcomed. I have personally seen very sad alternative things happen: collections being carelessly disbursed for pennies, tossed into the dumpster, or otherwise being perpetually kept out of reach of scientific investigators.

Drew Carhart
Naperville Astronomical Association
Naperville, Illinois
dcarhart@fieldmuseum.org

International Dark-Sky Association

TITLE PHOTOGRAPH: "RING GALAXY," AM 0644-741; CREDIT: NASA, ESA, AND THE HUBBLE HERITAGE TEAM (AURA/STSCI)

Billboards and Electronic Signs

Billboards and electronic signs can generate considerable controversy. Many consider billboards to be an environmental blight, and they are banned in some communities. Scenic America, for example, is a 501(c)(3) nonprofit organization "dedicated solely to preserving and enhancing the visual character of America's communities and countryside." Scenic America feels "our most cherished scenic resources…are being obscured by a blizzard of monstrous billboards, badly sited telecommunications towers, a tangle of overhead lines, and a hodgepodge of visual clutter." I recommend you study the Scenic America website at *www.scenic.org*.

Others, however, feel billboards serve legitimate advertising and informational purposes. When you are hungry, tired, and nearly out of gas late at night in an unfamiliar location, a billboard pointing the way to fuel, food, and lodging is a pretty sight indeed.

ScenicAmerica

The billboard industry is big business which aggressively seeks to protect its interests and spread its influence. IDA has no official position concerning billboards per se. What does concern IDA is billboard lighting and large digital billboards. Many billboards are poorly lit with much up light going into the sky and significant spill light. Such billboards contribute to light pollution and light trespass, and they may produce visual clutter and confusion for drivers.

We used to address billboard lighting issues by recommending all billboard lighting be shielded, shining from the top down on the billboard and focused in a manner so as not to produce much spill lighting. We also recommended any billboard lighting be turned off whenever the business being advertised was closed. While there was, and continues to be, pushback on these recommendations, a far larger problem has developed in the last decade: large electronic signs or digital billboards. These can be simple, small ground-mounted signs that are reasonably lit and provide good information and advertising. Unfortunately, many electronic billboards have morphed into huge TVs on sticks, with rapidly changing pictures distracting drivers and throwing large amount of light into neighboring homes and the night sky.

Large digital billboards are now prohibited in most parts of Arizona so they will not harm the many professional observatories in the state. Every community must rely on local conditions and customs for how they regulate billboards. I personally feel large digital billboards should be forbidden, certainly in environmentally sensitive areas.

There are several constraints that local advocates can press for if they are unsuccessful in fully banning digital billboards. One can try and prohibit their use at night, and one can try to limit their size, their number, and their placement. The maximum sign brightness at night should be limited to 100 nits. Nit is a unit of luminance commonly used by the billboard industry. A technical discussion of lighting terms is far beyond this column, but, anecdotally, 100 nits produces a sign bright enough to convey its message without being overlit.

Digital signs should not have white or light-colored backgrounds. There should be no motion, animation, and flashing messages on these signs. This is particularly annoying to those living near the signs and quite distracting for drivers. Rapidly changing messages are to be avoided. The message change should not be more frequently than once per fifteen seconds. Community aesthetics, traffic safety, and pedestrian safety may be adversely affected by brightly flashing, rapidly changing electronic signs.

Sweden has ordered the removal of all digital billboards. Such a countrywide prohibition does not seem feasible now in the United States. If digital billboards are becoming a part of your community scene, you can use the above recommendations as a starting point to help your community construct a workable situation in which digital signs do not detract from safety and aesthetics but convey useful information for businesses and their customers.

Tim Hunter, Co-founder, IDA
Phone: 520-293-3198; Fax: 520-293-3192
Email: *ida@darksky.org*;
www.darksky.org

TITLE PHOTOGRAPH: DWARF GALAXY NGC 1569; ESA, NASA, AND P. ANDERS (GÖTTINGEN UNIVERSITY GALAXY EVOLUTION GROUP, GERMANY)

Last month, I read a small piece in one of the magazines I received, explaining how a sixth grader won his school's science fair by making a tic-tac-toe machine that never lost. The winning entry was a small box with LEDs that lit after the player would push the button for his turn. The player always went first. When the child opened the box, there were some batteries, a few integrated circuits, LEDs, and wiring.

I was impressed by the creativity of the sixth grader and for a few moments thought about how technology has changed over the past many years. But as I thought more about it, a memory stirred about a much larger tic-tac-toe machine that was built by a sixth grader back in 1961, using relays, light bulbs, toggle switches, and a rather large power supply. This sixth grader also won his science fair. Other than the technology, the only thing about the 56-year-old unit was that this machine always won. No matter who went first (human or machine), the machine always won.

The 1961 model was built with some parts purchased on Canal Street in New York City. The total cost was perhaps five dollars. It was wired based on some simple logic diagrams, with the caveat that if the human appeared to be winning, the machine would turn on two lights at the same time, always winning.

Cheating, but winning. The teacher awarded the student for his creativity.

All of this opens the following questions: When was the last time you were at a science fair? Did you go as a judge, parent, or spectator? What did you find to be the most interesting exhibit?

I've judged hundreds of such fairs around the country (North Carolina, Texas, New Mexico, Arizona, and others), and frankly I'm somewhat surprised at the entries. From primary and secondary schools (K through 8 or 9), many of the displays were duplicates of what was done in the 1960s: stick a few electrodes in a potato and register voltage, grow green beans under various lighting and water conditions to see how they grew, or calculate whether showering or bathing took more water. In more than 90 percent of these exhibits, there was no creativity, zero originality, and minimal thought. After discussing the projects with the kids and teachers, my conclusion was that the teachers knew virtually nothing about the science they were supposed to be teaching, and kids were not learning science. A few kids brought in small telescopes, some color reproductions of Hubble photos, and that was their entire exhibit. When questioned, they knew almost nothing about how the telescope worked, what the images actually were, and why they were important.

One would think that with the availability of Google and smartphone-based applications, science projects for these grade levels would certainly be much better. To be sure, the higher grades (9 or 10 through 12) showed robots, laser applications, telescope building, biological research, and other wonderful things, but again, most of the students didn't have a clue about what they "built." It was very obvious that the entries were mainly either built by parents, or purchased and hastily put together, with a few exceptions. The exceptions earned my best scores. On the other stuff I made comments, discussed with the students and teachers, and walked away with a sense of despair. Is this what science in our schools coming to? How sad!

Ron Kramer, Editor

TITLE PHOTOGRAPH: M31; COMPLIMENTS OF TOM S. MARTINEZ, ASKC

Sweden, January 13, 2017

Impact Origin of Sweden's Siljan Ring

A celestial body with a diameter of five km crashed into the Earth's surface about 380 million years ago, forming the Siljan Ring in Dalarna, Sweden. The original impact crater was approximately 60 km in diameter and the bedrock was covered by a layer of sediments 2.5 km thick when the projectile struck, according to a doctoral thesis from Lund University in Sweden.

Lithosphere geologist Sanna Alwmark has researched the impact that produced Europe's largest impact structure, the Siljan Ring, a circle of lakes of which the largest is Siljan. She has also investigated the consequences of the collision on the bedrock.

Together with colleagues, Sanna Alwmark investigated a mineral known as shocked quartz. By mapping the extension of shocked quartz, the researchers were able to determine the shock pressure to which the bedrock was subjected in the impact.

"Combining the shock pressure estimates with numerical modelling, we were able to reconstruct the original impact crater, and to determine its size at 60 km in diameter. Our model also shows that the crater was formed by a projectile which was five km in diameter," says Sanna Alwmark. Furthermore, in Alwmark's assessment, the crystalline bedrock in the Siljan area at the time of the impact was covered by a layer of sediments 2.5 km thick.

Besides the impact crater in the Siljan area, Sanna Alwmark and her colleagues also located and investigated shocked quartz in the bedrock near the lakes of Målingen in Jämtland and Hummeln in Småland. "We prove that the two lakes were also formed through an impact," she says.

New Haven, Connecticut, December 20, 2016

Searching a Sea of "Noise" to Find Exoplanets Using Only Data as a Guide

Yale researchers have found a data-driven way to detect distant planets and refine the search for worlds similar to Earth. The new approach, outlined in a study published December 20 in *The Astronomical Journal*, relies on mathematical methods that have their foundations in physics research. Rather than trying to filter out the signal "noise" from stars around which exoplanets are orbiting, Yale scientists studied all of the signal information together to understand the intricacies within its structure.

"It requires nothing but the data itself, which is a game changer," said senior author John Wettlaufer, the A.M. Bateman Professor of Geophysics, Mathematics, and Physics at Yale. "Moreover, it allows us to compare our findings with other, traditional approaches and improve whatever modeling assumptions they use."

The search for exoplanets—planets found outside our own solar system—has increased dramatically in recent years. The effort is motivated, in part, by a desire to discover Earth analogs that might also support life.

Scientists have employed many techniques in this effort, including pulsar timing, direct imaging, and measuring the speed at which stars move either toward or away from Earth. Yet each of these techniques, individually or in combination, presents challenges. Primarily, those challenges have to do with eliminating extraneous data—noise—that doesn't match existing models of how planets are expected to behave. In this traditional interpretation of noise, searches can be hampered by data that obscures or mimics exoplanets.

Wettlaufer and his colleagues decided to look for exoplanets in the same way they had sorted through satellite data to find complex changes in Arctic sea ice. The formal name for the approach is "multi-fractal temporally weighted detrended fluctuation analysis" (MF-TWDFA). It sifts data at all time scales and extracts the underlying processes associated with them.

"A key idea is that events closer in time are more likely to be similar than those farther away in time," Wettlaufer said. "In the case of exoplanets, it is the fluctuations in a star's spectral intensity that we are dealing with." The use of multi-fractals in science and mathematics was pioneered at Yale by Benoit B. Mandelbrot and Katepalli Sreenivasan. For expertise in the search for exoplanets, the researchers consulted with Yale astrophysicist Debra Fischer, who has pioneered many approaches in the field.

The researchers confirmed the accuracy of their methodology by testing it against observations and simulation data of a known planet orbiting a star in the constellation Vulpecula, approximately 63 light-years from Earth.

Sahil Agarwal, a graduate student in the Yale Program in Applied Mathematics, is first author. Fabio Del Sordo, a joint postdoctoral fellow at Yale and in Stockholm, is co-author. Grants from NASA and the Swedish Research Council helped to fund the research, as did a Royal Society Wolfson Research Merit Award.

Baton Rouge, Louisiana, September 27, 2016

Unusual Martian Region Leaves Clues to Planet's Past

Researcher Don Hood from Louisiana State University and colleagues from collaborating universities studied an unusual region on Mars—an area with high elevation called Thaumasia Planum. They analyzed the geography and mineralogy of the area they termed Greater Thaumasia, which is about the size of North America. They also studied the chemistry of this area based on gamma-ray spectrometer data collected by the Mars Odyssey Orbiter, launched in 2001. What they found was the mountain ridge that outlines Greater Thaumasia was most likely created by a chain of volcanoes. The results were published recently in the *Journal of Geophysical Research–Planets*.

"The chemical changes we see moving northwestward through the region is consistent with the mantle evolving on Mars. Our research supports that this whole area was built as a volcanic construct," said Don Hood, LSU Department of Geology and Geophysics doctoral candidate and lead author of the paper.

"The chemical composition changes throughout the region. Silica and H_2O increase and potassium decreases from southeast to northwest.

"The chemical composition shifting is the key progression that tells us that this environment was most likely shaped by a series of volcanic events that continually erupted from a changing mantle composition," Hood said. Hood and colleagues from Stony Brook University, University of Tokyo, and Lehigh University ruled out another hypothesis that the abundance of H_2O and potassium was caused by water interacting in rock.

Continued on page 27

DEEP-SKY OBJECTS

THE OTHER LEO TRIO

By Dr. James R. Dire, Kauai Educational Association for Science & Astronomy

It is always exciting to view multiple galaxies in the same telescopic field of view. One of the best telescopic trios consists of the three spiral galaxies M65, M66, and NGC 3628 in the constellation Leo. Under clear, dark skies, a four-inch telescope with an eyepiece yielding one-degree field of view easily captures all of these faint fuzzies together. However, an 8- to 10-inch telescope is required to resolve some of their spiral structure. M65 and M66 are 9th magnitude, while NGC 3628 is a half-magnitude fainter.

Another triplet of galaxies in the constellation Leo consists of M105, NGC 3384, and NGC 3389. These galaxies are located 8 degrees west of M65, 9.5 degrees east of Regulus, or 1.67 degrees south of the magnitude 5.5 star Kappa Leonis. These three galaxies are contained in an area spanning a mere 10 arcminutes, so higher magnification can be used when viewing all three simultaneously. With a rich-field telescope at low magnification, these galaxies can also be placed in the eyepiece simultaneously with M95 and M96!

M105's integrated magnitude is approximately the same as that of NGC 3628. However, M105's light is concentrated over a smaller area, 5 arcminutes in diameter, making it much easier to see than NGC 3628. M105 is a giant elliptical galaxy. Its Hubble galaxy classification is E1, which means it appears nearly round. M105 is thought to be 35,000 light-years in diameter and has a mass of 140–200 billion solar masses. Both its size and mass are smaller than our own Milky Way Galaxy. A black hole at the center of M105 may be 50 million solar masses, roughly ten times more massive than the black hole at the center of the Milky Way.

M105 was discovered by Messier's assistant Pierre Méchain on March 24, 1781, a few days after he discovered M95 and M96. It is unclear why M105 never made it into Messier's original catalog. It was added to the modern Messier Catalog in 1947, along with M106 and M107, by astronomer Helen Sawyer Hogg, after finding a letter by Méchain describing them.

The second brightest galaxy in the M105 trio is NGC 3384. NGC 3384 shines at magnitude 10.9. NGC 3384's angular dimensions are 5.5 x 2.5 arcminutes. William Herschel discovered the galaxy in 1784. The core of NGC 3384 is almost as bright as M105's core. However, NGC 3384's brightness drops off much faster than M105's does away from the core. NGC 3384 was originally classified as an E7 (elongated elliptical) galaxy. More recent studies classify it as SB0, a barred lenticular galaxy. Lenticular galaxies are intermediate between spirals and ellipticals. NGC 3384 has a central black hole four times the mass of that at the center of the Milky Way.

The final galaxy in the M105 trio is NGC 3389, also discovered by Herschel in 1784. NGC 3389 is a 12th-magnitude spiral galaxy 2.7 x 1.2 arcminutes in size. All three galaxies can be spied clearly together with an 8-inch or larger telescope. These galaxies are approximately 35 million light-years distant and are all part of the M96 group of galaxies, sometimes referred to as the Leo I Group.

My wide-field image of the M105 group was taken with a Stellarvue SV102T refractor (102 mm, f/7.9) using a 0.8x focal reducer/field flattener. The exposure was 40 minutes using a Canon 30D camera. The images spans about two degrees from left to right. The brightest star in the field, to the upper right of the galaxies, is SAO 99280, magnitude 6.7. The inset view of the galaxies was taken with a 190 mm f/5.3 Maksutov-Newtonian with an SBIG ST-2000XCM CCD camera. The exposure was 30 minutes.

As can be seen in the image, elliptical galaxies demonstrate no structure at the eyepiece. The galaxy NGC 3389 is too small and faint to see any spiral structure in most amateur telescopes. However, capturing all three galaxies in the same eyepiece should be on everyone's observation list during spring galaxy searches!

You can contribute to science through Variable Star observations

By Stella Kafka, *Director, American Association of Variable Star Observers*

The mission of the American Association of Variable Star Observers (AAVSO, *www.aavso.org*) is to enable anyone, anywhere, to participate in scientific discovery through variable star astronomy. For more than 100 years, the AAVSO has been building an international community of astro-enthusiasts who strive to study and to understand some of the most dynamic, unpredictable, and fun phenomena in the night sky. The AAVSO data are everywhere: in science papers, in press releases, in observing-alert responses, and in citizen science projects. The AAVSO is beyond borders—it is an international multi-cultural collaboration, as science is. Many professional astronomers took their first steps through the AAVSO. And, because of the AAVSO, many non-professional astronomers are involved in high-profile projects.

This is not to say that variable star observing is difficult. I started my Binocular Variable Stars Observing Program as a "dare" from our members, and I got addicted to it! It is fascinating to observe a star one night, estimate its magnitude, and five nights later notice that it has changed. Witnessing with my own eyes a phenomenon that is happening many light-years away (and probably has been "broadcasting" its light for millions of years) is an amazing experience. Recording those changes and submitting them to the AAVSO International Database gives me the sense that I belong to a committed international community, and the satisfaction that my data will be used some day for a research project and can make a difference. I am now working towards my 60 observations and I can't wait to get my AL Binocular Variable Stars pin.

As we have entered a golden era of time-domain astrophysics, observations from our community are an increasingly vital resource for professional astronomers to obtain ground-based light curves of variable stars. Along with the Astronomical League, the AAVSO is continuously training and encouraging observers to improve their observing skills. You can get started at your leisure with the League's Binocular and Telescopic Variable Stars Observing Programs, you can learn more through the AAVSO's CHOICE courses and seminars, and you can join our conversations through our forums. Together, we are building a community of citizen astronomers who push the boundaries of science by contributing variable star data. I hope you will join us!

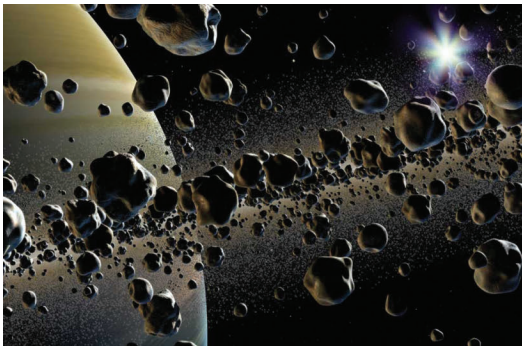
Wanderers in the Neighborhood

The Rings of Saturn

By Berton Stevens

Many people consider the most beautiful planet in our solar system to be the sixth planet, Saturn, known for its spectacular ring system. Even with a small telescope, the rings of Saturn are a standout view for both amateur astronomers and the public. Rings have been found around other planets, but none in our solar system compare with those around Saturn.

Saturn has been known since ancient times. However, its rings are not visible to the naked eye, delaying their discovery until the invention of the telescope. Galileo Galilei first observed Saturn telescopically in 1610, describing Saturn as having "ears" or being made of three objects in a row. It was not until 1655 that Christiaan Huygens suggested that they were not separate objects, but rings around Saturn. By 1675, the improvement in telescopes allowed Giovanni Cassini to see the gap in the rings that was later named after him—the Cassini Division. He is also the namesake of the Cassini spacecraft that has given us incredible close-up images of Saturn, its moons, and its rings.



An artist's conception by Joe Bergeron of the rings of Saturn viewed from inside the rings themselves. The particles of ice that compose the rings range from the size of dust to small-mountain-size chunks. The ring system begins from the inside out with the D, C, B, and A Rings, followed by the F, G, and E Rings. Image copyright Joe Bergeron, www.joebergeron.com/particles.html. *This is a new version of an old image he made for Time-Life Books.*

While the rings look solid from Earth, solid rings would be unstable and break up. It quickly became clear that they were composed of individual particles traveling in similar orbits. Spectroscopic observations of the rings showed that the ring particles are 99.9 percent pure water-ice. The rings are also extremely thin. If the rings were reduced to the size of a compact disc, they would be the only one one-hundredth the thickness of a human hair.

From Earth's perspective, the rings are always illuminated by the Sun, except when Saturn's shadow appears on the back side of the rings. The shadow is most visible when the Earth is furthest from the Sun from Saturn's point of view. This occurs when Saturn is at quadrature (ninety degrees from the Sun) as viewed from the Earth. The shadow appears on the rings east of the planet's disk when Saturn is in western quadrature (ninety degrees west of the Sun in the morning sky) and west of the disk when Saturn is in eastern quadrature (ninety degrees east of the Sun in the evening sky).

Images from even the best telescopes, immersed in Earth's distorting atmosphere, cannot compare to the view from a spacecraft. The first terrestrial visitor to Saturn was the Pioneer 11 spacecraft in late 1979. It discovered the F Ring and two new moons. Pioneer 11 was followed by Voyager 1 and Voyager 2, which made even more discoveries. The Cassini spacecraft was the first to orbit Saturn and make close-up measurements of the planet, moons, and rings, starting in July 2004.

Images from these spacecraft and the Hubble Space Telescope have allowed us to learn a great deal more about Saturn's rings. The three main rings, working outward from the planet, are designated C, B, and A. At low resolution, they appear to be uniformly dense. Higher-resolution images, however, show that hundreds of individual ringlets compose each ring.

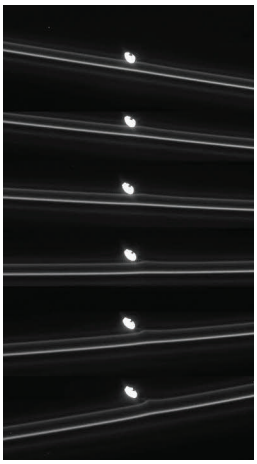
The ringlets are not solid either: they are composed of myriad particles of water-ice, from dust-size to tens of feet wide and larger. While these particles appear to form ringlets with empty gaps in between, the rings are best thought of as a continuous disk with areas that have higher and lower concentrations of particles. Much of this clumping is caused by gravity from Saturn's moons. The lower-density areas are called gaps or divisions.

In 2008, the International Astronomical Union defined a gap as a space within a named ring. They also defined a division as separating two named rings. Divisions are usually large and gaps are much smaller. The most famous division is the Cassini Division, which separates the A and B Rings. The Cassini Division is clearly visible using Earth-bound telescopes.

Each particle in the rings is in an independent orbit around Saturn. These orbits are influenced by the gravity of Saturn's moons. For example, the Cassini Division has a reduced particle density because gravity from the moon Mimas changes the orbits of particles in the Cassini Division, moving them either inward or outward and clearing the division.

The features observed in the ring system were exclusively attributed to the gravitational influences of the moons until 1980, when images from Voyager 1 showed almost linear features stretching radially outward in the B Ring. Dubbed spokes, these features are dark when the Sun is behind the observer (frontlit) and bright when the Sun is on the opposite side of the rings than the observer (backlit). The spokes rotate at a different rate than the rings, but they are still long-lasting features. Their motion could not be attributed to the moons' gravity.

The spokes rotate around Saturn at virtually the same speed as Saturn's magnetic field. While the exact mechanism that creates the spokes is unknown, it is believed that they are microscopic dust particles suspended above the rings by electrostatic repulsion. Even more surprising is that the Cassini spacecraft did not see the spokes when it first arrived at Saturn in early 2004. Astronomers continued to look for them and finally found them in early September 2005. They seem to be a seasonal phenomenon appearing only around the Saturnian equinoxes.



Saturn's potato-shaped moon Prometheus, discovered in 1980 by Voyager 1, is a shepherd moon helping to confine the F Ring. This sequence of images shows Prometheus's gravity distorting the F Ring. Prometheus is 84 x 49 x 37 miles across and orbits Saturn in just 15 hours. The Cassini spacecraft provided the original images. Credit: NASA/JPL-Caltech/Space Science Institute

After twelve years of making close-up observations of Saturn, the Cassini mission is ending. Mission Control has kept Cassini away from Saturn's rings to prevent an errant ring particle from destroying the spacecraft. Now, with maneuvering propellant running out, Cassini will be sent through the edge of the rings to make close-up observations of the rings and small moons. Later, Cassini

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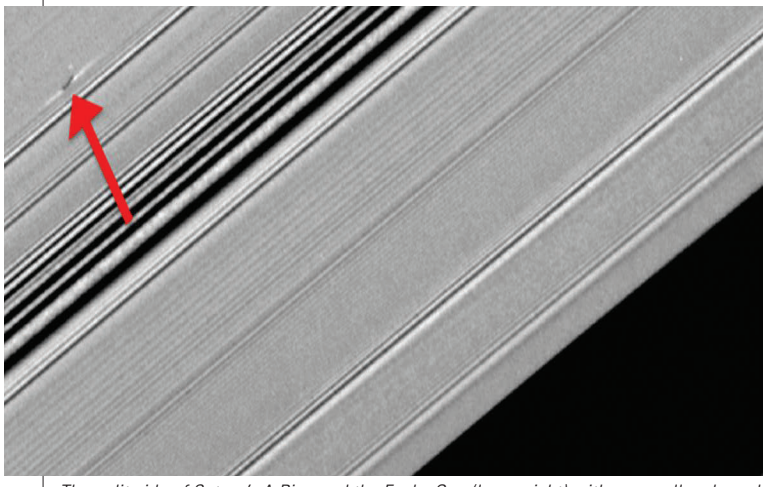
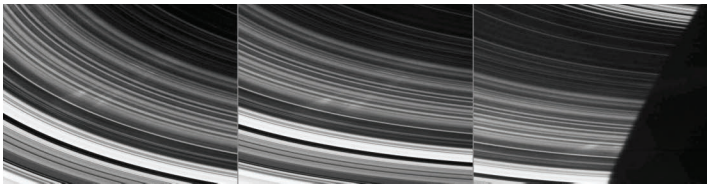


The unlit side of Saturn's A Ring and the Encke Gap (lower right) with a propeller-shaped structure (red arrow) caused by a tiny moon around half a mile across, invisible in this image. The moon has cleared material to its left and right, allowing more sunlight through from the sunlit side. Closer to the moon, ring material is more densely concentrated, making the darker propeller shape. There are several of these propeller-moons scattered throughout Saturn's rings, though this is one of the largest. This image was taken with the Cassini spacecraft's narrow-angle camera on August 19, 2008. Credit: NASA/JPL-Caltech/Space Science Institute

The mysterious spokes of Saturn's rings were first discovered by Voyager 1 in 1980. Since then, they had only been seen in Hubble images until the Cassini spacecraft arrived at Saturn in 2004. These three images, taken twenty-seven minutes apart by Cassini, show the motion of the spokes as they move from left to right. The faint, narrow spokes on the B Ring are 2,200 miles long and about 60 miles wide. The final image shows them disappearing into Saturn's shadow. These images were taken on September 5, 2005. Courtesy NASA/JPL-Caltech.



Solar Minimum Observing

There's more to see than just sunspots

By Jamey L. Jenkins, Member-at-Large

It was during the early- to mid-1800s that S. Heinrich Schwabe conducted his search for an intra-Mercurial planet, and stumbled upon the hitherto unknown 11-year solar activity cycle. Beginning with "solar cycle 1" (1755–1766), we have experienced 23 full solar cycles. Presently the 24th is winding down, with recurring instances of a nearly spotless, seemingly quiet Sun.

The Sun, however, is never a static lifeless celestial body; rather it is a churning, boiling, and living star! At those times of outwardly scarce sunspot activity there might yet be *something* brewing on the Sun. Other solar features are often right before our eyes, if you know what to look for. Let me describe a variety of features that have been spotted and appreciated during many solar observing sessions, even at solar minimum.

What You Can See

Through a white-light telescope, limb darkening is obvious at the lowest of magnifications. Position the Sun's disk near the center of a low-power eyepiece and notice that the fringe of the Sun is a bit darker than the mid-region. We have an ability to look a little deeper into the solar interior at the center than we do near the edges, where gas has a greater cumulative opacity. Approaching the limb, we only see cooler upper layers of the photosphere; near the middle we can glimpse the hotter and brighter inner layers.

Solar granulation is a low-contrast, minuscule feature that covers the entire visible disc of the Sun. The granules are small (1–5 arcseconds) and require higher magnification and superb seeing conditions to resolve. A difficult catch, but they are always present. A granule is the apex of a column of plasma rising from the solar interior. Changes in appearance are usually evident after a minute or so, each granule having a lifetime on the order of 5–10 minutes. Observing tip: a green or blue eyepiece filter that supplements (but does not replace!) the primary solar filtration increases granule contrast, enhancing visibility.

Author's 102 mm f/7 Megrez (William Optics) telescope fitted for H-alpha solar observing and imaging. On the objective end is a Lunt 100 mm energy rejection filter, at the eye end a 2x Tele Vue Powermate, Daystar Quark chromosphere filter, and an Imaging Source DMK 41AU02 video camera.

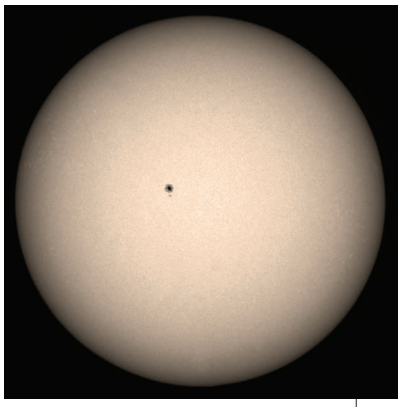
Also at the angular size of granulation we find pores (the precursor to sunspots), which sporadically pop in and out of view. A pore looks like a granule that has been filled with dark material. Small pores can form and dissolve in several minutes while bigger instances may last several hours. The largest examples often morph into mature sunspots.

Best visible when situated near the solar limb are faculae, the pale wispy streaks that accompany and precede sunspot groups. Faculae may be glimpsed without any attending sunspots. In fact, tiny bits and pieces of faculae sometimes form near the poles, frequently during sunspot minimum. The lifetimes of these polar faculae are several minutes to several days.

Again, the contrast of faculae, like that of granulation, will be boosted with the addition of a green or blue eyepiece filter.

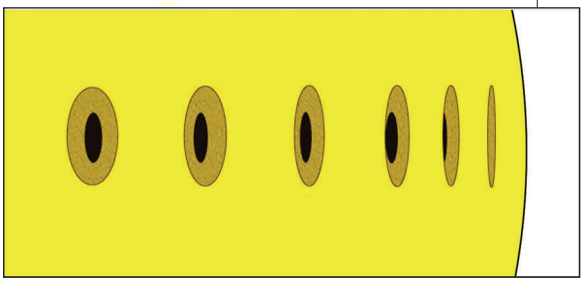
If, by chance, the Sun develops a compact, round sunspot at solar minimum, watch as it nudges the west limb for the foreshortening byproduct known as the Wilson effect. Within a couple days of approaching the limb, the symmetrical spot appears to become narrower from foreshortening. As the penumbra and umbra become thinner, the umbra will seem to move closer and closer to the penumbral side nearest the Sun's center. Continued solar rotation causes the umbra to narrow and eventually disappear. Alexander Wilson discovered this phenomenon in 1769, attributing it to the supposed concave shape of sunspots. Nowadays we believe the effect has less to do with sunspot shape and more with transparency of photospheric gas.

Observers of Ca II K-line light at 393.4 nm can spot plages in the chromosphere. A plage can be thought of as an extension of a photospheric facula upward into the lower chromosphere. Plages consist of numerous tiny bright features, many associated with emerging magnetic flux tubes. Therefore, views at the Ca II K-line permit observation of magnetic structures on the Sun. In a plage, strong magnetic fields appear brighter than weak fields. While you are at it, look for the plage corridor, a void separating the positive and negative regions of the magnetic field. In young plages the corridor is sharp and narrow; in older specimens it appears diffuse and fuzzy.

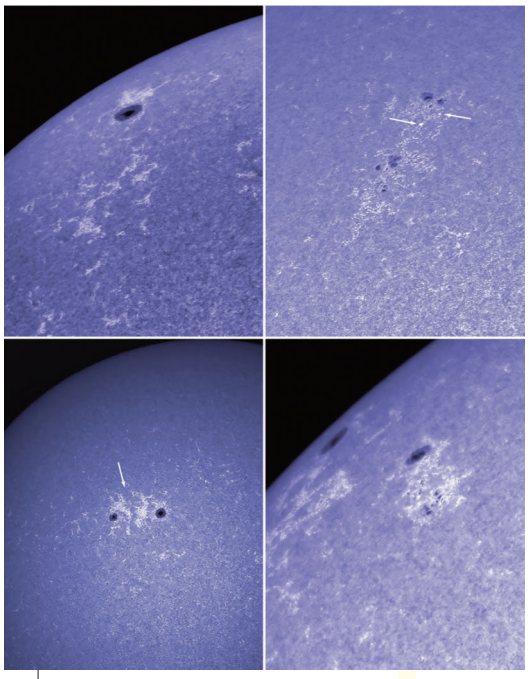


Solar minimum Sun typically displays few sunspots. Limb darkening is obvious in this whole-disk view. All illustrations in this article are by the author.

Ellerman bombs are visible in the lower chromosphere near early plages as small micro flares. Ca II K or in the wings of H-alpha light is where you see these features as 3 arcsecond or smaller bright points. An Ellerman bomb may "pop" in and out of view with a lifetime of 5–10 minutes. They are thought to result from magnetic reconnection events on the Sun.



The Wilson effect shows the apparent concave nature of sunspots. From left to right, we see the progression of a sunspot exiting the west limb. For a sunspot entering the east limb, the order is reversed.



These Ca II K-line images show plages and Ellerman bombs in progress. In the upper right frame two Ellerman bombs (micro-flares) are arrowed. The lower left frame depicts a bipolar sunspot group with the plage corridor arrowed. A small symmetrical spot nearest the limb in the lower right image displays the Wilson effect.

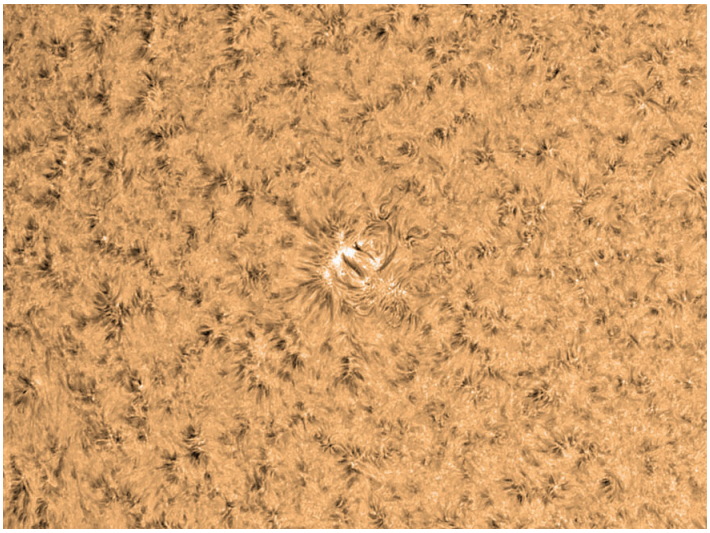
Many observers today explore the Sun with a specialized telescope or filter that passes light from the H-alpha line at 656.3 nm. Visible around the Sun's periphery in H-alpha light are the spicules, curious features similar to gas jets spiking upward at nearly 20 km per second to a height of nearly 10,000 km. Spicules typically have a 10-minute life ended by disappearing or falling back into the Sun. The same spicules visible against the solar disk align themselves into many interesting patterns. Three common forms are the bush, chain, and rosette. Random clusters of spicules are called a bush. When spicules align themselves into a column or row, we say they are a chain. Radiating spicules, like the petals of a flower, are known as a rosette, a very eye-pleasing formation.

Two of the most spectacular solar features in H-alpha light are the bright prominences and dark filaments. They are one and the same feature—gas clouds suspended above the solar surface by magnetic forces—the difference being where they are positioned. When situated on the solar limb, we see a glowing prominence. Positioned before the solar disk, we call the prominence a filament, now dark because of its cool temperature relative to the solar background. They assume a couple of basic classifications, quiescent or eruptive. The quiescent prominence is quiet and well behaved, changing appearance only slightly with time. Eruptive prominences, on the other hand, appear moving and agitated, and sometimes even burst away from the Sun at hundreds of km per second.

Prominences take on numerous shapes and forms. Common structures include the haystack or curtain, tree trunk, pillar, loop, and tornado. Prominence study can encompass morphology and statistical investigations of frequency, position, area, and height, or even the creation of captivating video. The rule of thumb for a solar observer regarding prominence development is that anything seems possible.

A recent H-alpha picture (June 25, 2016) showing the gas jet nature of spicules on the limb. A large "haystack" prominence is in the center while the "hairy" features on the disc are spicules.

Another feature on the H-alpha Sun that literally pops up now and again is the emerging flux region (EFR). Tubes of magnetic flux poke up through the photosphere to form a small patch of plage, the initial EFR. On occasion, an arch filament system may develop within the EFR, composed of dark, thick threads (filaments) that cross the magnetic negative to positive zones of the EFR. These tiny filaments are low in the chromosphere and when found near the solar limb as bright objects are increasingly difficult to see. The EFR is a precursor to the development of an active region.



This emerging flux region and the attending arch filament system appeared on the Sun on August 4, 2016. Surrounding the EFR in this H-alpha image are numerous patterns of spicules.

Under the Skies

The Sun, in my opinion, is one of the most exciting objects in the sky to observe. Where else in the universe can one see spectacular changes transpire at a minute-by-minute pace? The features reviewed here illustrate the degree of the Sun's energetic and sometimes dramatic nature, providing the astronomer an alternative to long nights and cold fingers searching for the next faint fuzzy.

If this awakens an interest in the Sun, check out the Astronomical League's Sunspotter and Hydrogen Alpha Observing Programs or contact the solar sections of the Association of Lunar and Planetary Observers or American Association of Variable Star Observers for additional information on observing the Sun.

Solar minimum normally limits the amount of spot activity we can view, but by turning a discerning eye toward the Sun, you too will discover that there really is more to see than just sunspots.

Warning: Solar observing can be a dangerous activity if done improperly! Only observe the Sun through a proper filter that covers the aperture (not the eyepiece) and removes both infrared and ultraviolet light while dimming its visual brightness to a safe and comfortable level. Never look at the Sun with your unfiltered eyes or telescope. Additional information on safe solar observing can be found at *www.aavso.org/solar-guidelines*.

ALCon 2016 "A CapitAL CONvention"!

By David Werth, the ALCon 2016 chair and member of the Northern Virginia Astronomy Club.

After enjoying the dark skies and hospitality of Las Cruces, New Mexico, in 2015, the annual Astronomical League convention came to the bright lights of the nation's capital for ALCon 2016, August 10th through the 13th, hosted by the Northern Virginia Astronomy Club (NOVAC).

Our late club president, Phil Wherry, always joked that NOVAC was the largest amateur astronomy club in the universe. (Well, try and disprove it!) So, when Phil brought the League's invitation to the board for our club to host the 2016 event, we felt we had the right dynamic to pull it off. We also felt, with the abundance of first-class speakers in the area and many excellent locations for field trips, that we could give the AL membership a fun and interesting convention.

The first thing that needed clarifying was where to host the event. It would have been ideal to hold the convention in Washington, D.C., but costs there were prohibitive so we looked hard at taking things across the Potomac into Arlington, Virginia. We were fortunate to find that the National Rural Electric Cooperative Association (NRECA) headquarters building had everything we would need for facilities, it had a prime location just five Metro stops from the city, and it would save us $20,000 to $30,000 over using a hotel. Sealing the deal was that there were several fine hotels within easy walking distance where attendees could stay.

After we made our suggestions to the AL leadership, John Goss and Carroll Iorg traveled to Arlington in March of last year to view the NRECA facility and three of the hotels. They came away duly impressed and we had the "go" to start building out the ALCon 2016 program.

Field Trips

The Washington, D.C., metro area provided us with some unique opportunities for special tours and we wanted to aggressively pack as many field trips as we could into a three-day period. We wound up with three field trips each to five different sites and set things up so that a clever person could possibly get to all five.

The Smithsonian Institution's National Air and Space Museum is the city's most popular tourist attraction, and special tours were led there by curators with displays including the Wright Brothers' first airplane; Charles Lindbergh's Spirit of Saint Louis; original Mercury, Gemini, and Apollo spacecraft; and a full-sized mockup of Skylab. Visitors were also able to visit the museum's Phoebe Waterman Haas Public Observatory for some daytime solar viewing.

The Stephen F. Udvar-Hazy Center is the Air and Space Museum's vast annex where visitors could view the Space Shuttle Discovery, the World War II bomber Enola Gay, a Concorde SST, and many other historic airplanes, jets, and space artifacts. At both the downtown museum and the annex near Dulles Airport, there is really too much to see on one two-hour tour, so we hope our guests were able to revisit these sites on their own to get the full experience each has to offer.

Visitors who took the tour to the meteorite collection at the Smithsonian Institution's National Museum of Natural History were expecting to just be guided through the normal displays that all tourists get to see. Imagine their surprise when one of the curators took them into their work areas, provided them with gloves, and let them handle large meteorites themselves while learning about each rock firsthand. The NMNH has one of the largest and best museum-based collections of meteorites in the world.

NOVAC is fortunate in having a club member who is the public liaison officer at the historic U.S. Naval Observatory. Geoff Chester gave our attendees an intimate tour of the 26-inch "Great Equatorial" refracting telescope, the voluminous reading room (where copies of the *Reflector* were spotted) and the Clock Room where the Department of Defense official time is kept. Several attendees commented on how much time Geoff gave each tour beyond what was scheduled. Did you know that the two Martian moons, Phobos and Deimos, were discovered at the original site of the USNO by noted American astronomer Asaph Hall in August 1877?

The most popular tour was to NASA's Goddard Space Flight Center in nearby Greenbelt, Maryland. Tour guides joined

DAVID WERTH

Dr. Harold Geller of George Mason University marked the 40th anniversary of the Mars Viking missions.


DAVID WERTH

Dr. Stella Kafka, Director of AAVSO, presented on Variable Stars and Their Stories.


DAVID WERTH

Vivian White of NASA's Night Sky Network held a workshop on preparing your community for the 2017 solar eclipse.

our guests on their coaches and took them around to the different buildings, giving special up-close views of the work going on there including Mission Control where various missions are managed. Of particular interest was the clean room where the James Webb Space Telescope is being assembled and tested. JWST is scheduled to launch in 2018 as the replacement for the Hubble Space Telescope.

Speakers

In planning the ALCon program we wanted to present quality over quantity, limiting the plenary session presentations to just sixteen guest speakers.

The Association of Lunar and Planetary Observers (ALPO) was strongly represented by six speakers. Leading off, Matt Will gave a look at "ALPO's Origins, Purposes, and Progress." Dr. Mike Reynolds followed with a talk titled "Rocks from Space," an "everything you wanted to know but were afraid to ask" look at meteorites.

Dr. Julius Benton was unable to attend, but his talk, "Observing Venus with ALPO," was ably presented by Ken Poshedly. Vincent Giovannone spoke on "30 Years of Perseids Meteor Observing," followed by Dr. John Westfall who gave us an interesting historical look at the Aristarchus experiment for measuring the distance between the Earth and the Sun. Mike

JOE TESSMER

Keynote speaker, NASA Administrator General Charles F. Bolden, Jr.

Reynolds made an encore presentation and shared his lifetime fascination with his talk, "46 Years of Total Solar Eclipse Chasing."

We also wanted to share the very real assets NOVAC has within our large club through a number of presentations by club members. Dr. Genevieve de Messieres, who manages the astronomy education program at the Smithsonian's National Air and Space Museum, gave an interactive presentation titled "Young Children at Your Telescope." There was some energetic back and forth with the audience on what works and what does not during public outreach events, a subject we can all relate to.

Kevin Quin, lawyer by day, astrophotographer by night, presented "Astrophotography Without Superpowers." From Kevin's "Hole in the Trees Skybox"—just his backyard in suburban Vienna, Virginia—he has taken some absolutely amazing astrophotos. His talk provided the audience with recommendations on preferred cameras and software for doing this from your own backyard.

Dr. Harold Geller noted that this was the anniversary year of one of NASA's greatest programs, with his talk, "40 Years Ago We Touched the Surface of Mars," a detailed account of the history of the Viking mission, which played a large part in his professional life.

Dr. George Dosheck, who in 2015 was awarded the prestigious George Ellery Hale Prize in solar physics for his contributions over an extended period of time to the field of solar astronomy, presented "Our Sun and its Mysterious Atmosphere."

Last but not least, JPL Solar System Ambassador Greg Redfern unveiled the truth behind "The Chesapeake Bay Impact Crater—A Cosmic Detective Story." Greg brought geologic samples, personally taken from the site, for the audience to examine.

We were also fortunate to have some distinguished special guest speakers from outside of NOVAC. Dr. David DeVorkin, senior curator of history of astronomy and the space sciences at the National Air and Space Museum, gave an interesting talk titled "Bringing Astronomy to the Nation's Mall"—very relevant for those who would soon be visiting those downtown sites in person.

With the recent detection of gravitational waves from binary black holes, it was only proper that Gregg Harry, a member of the Laser Interferometer Gravitational-Wave Observatory (LIGO) team, gave a presentation on gravitational wave astronomy. Gregg illuminated the latest findings and spoke about future plans for the program.

Speaking of timely topics in astronomy and the space sciences, how about an update on the New Horizons mission to Pluto and Charon? We had just the man in Dr. Mike Summers of George Mason University. With about 90 percent of the New Horizon's data downloaded at the time, Mike showed us amazing new photos plus atmospheric and geologic data on these distant worlds. And Mike is leading a charge to have Pluto reestablished as a planet. Get in touch with Mike if you feel the same!

Workshops

In addition to the roster of guest speakers in the main hall, we wanted to offer the attendees some hands-on alternatives with several special workshops. North Carolinian Christi Whitworth of the Pisgah Astronomical Research Institute (PARI) and local D.C. legend

Continued on page 20

DAVID WERTH

AL president John Goss and friends examine one of the displays in the vendor room.

DAVID WERTH

Dr. David Dunham of IOTA had an interactive display on occultations.

BILL BURTON

At the Smithsonian's National Museum of Natural History meteorite collection, Laurel Wanrow, holding a pallasite.

For most of us, the excitement of our hobby is the time we spend under the stars, but because amateur astronomers comprise a diverse community, our observing circumstances vary considerably. We have different sizes of telescopes or binoculars and varying levels of experience. We may prefer visual, imaging or sketching. Some of us belong to clubs and others don't. There are those who can observe under dark skies from home, while many must tolerate annoying levels of light pollution or pack up and drive miles to suitably dark skies.

The Astronomical League has its members covered. Its menu of over 50 observing programs specifically addresses the needs resulting from all of these considerations. The programs provide ample opportunities for experienced observers, newcomers, owners of all kinds of instruments, those with less familiarity (including beginners and youngsters), and observers constrained by varying degrees of light-polluted skies. In fact, as an example of this diversity, there's even a suite of programs for the Southern Hemisphere. So, when you find yourself thinking, "I feel like getting the scope out tonight, I wonder what is there to see?," the League has you covered, and can turn your observing uncertainty into observing enjoyment.

The observing programs include customized lists of the best celestial targets visible under virtually any sky condition, whether dark skies or annoying glow. In fact, the Urban Program is especially for observers who can't see the Milky Way at all. The numerous benefits of these programs have been widely recognized and acknowledged over the years, but the one most often mentioned is that they provide an incentive to go out and use your telescope.

"The programs are meant to encourage our members to get out and experience the wonder, beauty, and mystery of the night sky," says Astronomical League president John Goss. He emphasizes the League's core mission: to promote the science of astronomy by fostering astronomical education and by providing incentives for observation and research. This is done by assisting communication among the League's 298 affiliated astronomy clubs, as well as a sizeable community of members-at-large, patron members, and supporting members, a total of over 16,000 individuals. "The League's highly successful roster of observing programs, along with award certificates and pins upon completion, is a core benefit of membership," Goss points out.

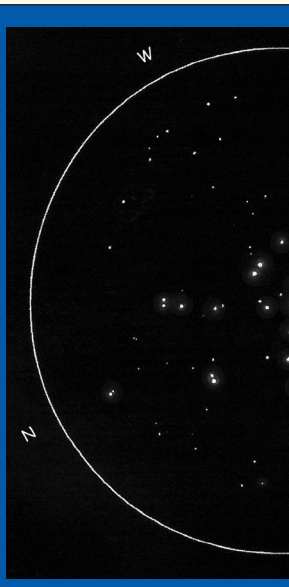
The League's inventory of programs has been evolving through the years since the introduction of the Messier Club in 1967. It has been the League's most popular program ever since, with over 2,700 awards presented to members. Launched in 1980, the Herschel 400 Club was the League's second program, and its award certificate is one of the most highly prized. However, the Binocular Messier Club, launched in 1991, is second highest in overall member participation. Following the success of these three clubs (now called programs), there followed a succession of offerings that have also become favorites among League observers: Lunar, Double Star, Binocular Deep Sky, Caldwell, and Globular Cluster programs.

Sue French, popular astronomy writer and "Deep-Sky Wonders" columnist for *Sky & Telescope*, reflects on her own early experiences with the League's observing programs. "A few years after beginning my first tentative explorations of the night sky, I joined a local astronomy club and learned about the Astronomical League. The League's Messier Observing

WHAT TO LOOK AT TONIG

By Bob Kerr

Framed award certificates make an attractive wall display. Photo by Mark Clingan



Binocular Double Star Program Log Sheet

OBJECT / CONST	DATE/TIME/OTHER				NOTES
1	DATE	22-Feb-14	TIME	3:40	Easy split. Kappa 1 is the brightest, kappa 2 appears to be about half as bright. White, pale red. Can just barely fit the two kappa's and Aldebaran in the same field of view.
	SEEING	3	TRANS	4	
	BINO/NAKED EYE/BOTH:		Bino		
Kappa 1 & 2	BINO INFO AND MOUNT:		8x40 HH		
Taurus	LOCATION	Rock Island, IL			
2	DATE	22-Feb-14	TIME	3:50	Bright, easy split. Both appear white. They are part of the Hyades cluster. Particularly noteworthy is that I could fit both kappa 1 & 2 and theta 1 & 2 in the same field of view. They are pointing towards each other, with the fainter star of each pair facing each other.
	SEEING	3	TRANS	4	
	BINO/NAKED EYE/BOTH:		Bino		
Theta 2 & 1	BINO INFO AND MOUNT:		8x40 HH		
Taurus	LOCATION	Rock Island, IL			
3	DATE	22-Feb-14	TIME	4:05	Two bright stars almost equal in magnitude. In same field of view with theta 1&2. Aldebaran is fairly close. The two pairs of doubles form a nice attractive grouping with Aldebaran.
	SEEING	3	TRANS	4	
	BINO/NAKED EYE/BOTH:		Bino		
Sigma 2 & 1	BINO INFO AND MOUNT:		8x40 HH		
Taurus	LOCATION	Rock Island, IL			
4	DATE	22-Feb-14	TIME	4:15	While I can split them, I can barely see 42. 45 is brighter. Neither one shows any color. M42 and the belt stars of Orion are in the same field of view.
	SEEING	3	TRANS	4	
	BINO/NAKED EYE/BOTH:		Bino		
42 & 45	BINO INFO AND MOUNT:		8x40 HH		
Orion	LOCATION	Rock Island, IL			
5	DATE	31-Jan-15	TIME	2:10	Beautiful bright primary with a delicate companion just N of it. Entire Belt of Orion is visible in the field of view.
	SEEING	4	TRANS	3.9	
	BINO/NAKED EYE/BOTH:		Bino		
Delta	BINO INFO AND MOUNT:		15x70 MT		
Orion	LOCATION	Rock Island, IL			
6	DATE	31-Jan-15	TIME	2:30	Fairly bright primary with a slightly fainter bluish secondary just to the E. Located on E edge of Great Orion Nebula. Gorgeous view of entire Sword of Orion!
	SEEING	4	TRANS	3.9	
	BINO/NAKED EYE/BOTH:		Bino		
Theta 2	BINO INFO AND MOUNT:		15x70 MT		
Orion	LOCATION	Rock Island, IL			
7	DATE	31-Jan-15	TIME	2:40	Nice fairly wide double. Yellow primary and pale orange or red secondary north of the primary. Nothing remarkable about the field after the previous observing sessions.
	SEEING	4	TRANS	3.9	
	BINO/NAKED EYE/BOTH:		Bino		
Gamma	BINO INFO AND MOUNT:		15x70 MT		
Lepus	LOCATION	Rock Island, IL			
8	DATE	31-Jan-15	TIME	2:50	Gorgeous quadruple! Marks the upper left corner of the Pleiades bowl. All are easily split, but the faintest component could be seen only with averted vision due to the waxing gibbous moon.
	SEEING	4	TRANS	3.9	
	BINO/NAKED EYE/BOTH:		Bino		
Eta	BINO INFO AND MOUNT:		15x70 MT		
Taurus	LOCATION	Rock Island, IL			

A nicely organized and detailed log sheet with all required data included

Observing log submission: an Excel spreadsheet by Ken Boquist of the Popular Astronomy Club

The Horsehead Nebula (B33) and its surroundings were captured as a single 300-second image at ISO 1600 on January 23, 2015, using a full-spectrum, monochrome-modified Canon T3 DSLR and 6 nm H-alpha filter, Tele Vue 127is refractor, and Paramount MX. Capture via BackyardEOS; calibration and noise removal in ImagesPlus; cropping, curves, and level adjustment in Photoshop.
By Anthony J. Kroes, Master Observer No. 15, Quantum Skies Observatory, Neville Public Museum Astronomical Society

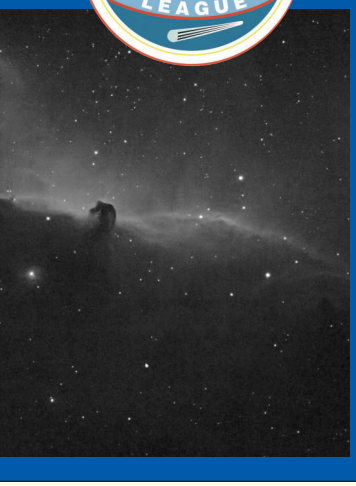
HT? THERE'S A PROGRAM FOR THAT

Sketch of M34 by Cindy Krach

Arp 26 (M101) from the Arp Peculiar Galaxies Program. Also known as the Pinwheel Galaxy, it is notable for its asymmetric shape and one particularly heavy arm. Total exposure was 30 minutes through a PlaneWave CDK 12.5-inch telescope and an L filter.
By Hilary Jones, Tri-Valley Stargazers

Stylish observing award pins accompany each certificate.

2015 National Young Astronomer Award (NYAA) presented to Theodora Mautz at ALCon 2015 in Las Cruces, New Mexico
Photo by Dale Taylor



Program led me to find and describe all the Messier objects in the League's booklet, which was very useful for a novice like me. I had a lot of fun and proudly received my certificate in 1980. I next tackled the Herschel 400 Program, which I can honestly say taught me how to observe. But you don't need to be just a deep-sky enthusiast to enjoy the League's programs."

The coauthors of the well-respected *Night Sky Observer's Guide*, George Kepple and Glen Sanner, are long-time Astronomical League members and active program participants. According to Kepple, "These programs give you a sense of purpose and a list of objects you might not have observed before." Sanner hadn't undertaken a program until a fellow Huachuca Astronomy Club member suggested he give it a try. "I soon jumped in with both feet," he recalls. "Any of the League programs are a way to discover the great variety of objects to be enjoyed at the eyepiece."

In 2001, to recognize those members whose interests are broad and whose skills are deep, the League introduced the Master Observer Award. This prestigious award requires a breadth of observing knowledge while also permitting members to pursue special interests. To qualify, at least ten programs must be completed, including a suite of five core programs, of which the Herschel 400 is one. Currently, the League has 175 members who proudly bear the distinction of Master Observer. Recently, the League announced a major enhancement under the new title of Master Observer Progression. This is largely in response to the substantial growth in the number of League programs introduced since 2001, as well as the continuing mastery of astronomy by League members seeking new challenges. The Progression includes six levels ranging from the Observer Award to Master

Observer Platinum Award. The existing Master Observer Program remains the same, but is now one of the steps in the Progression.

National Observing Program directors Aaron Clevenson and Cliff Mygatt stay busy keeping all these programs on track and assuring the League's "celestial machinery" is properly oiled and running. According to Clevenson, "The goal is to provide observing subjects of interest to everyone, with differing levels of complexity and varying equipment requirements. The programs are structured not only to provide a list of things to see but also to provide the opportunity for the observer to learn about those objects and astronomy in general." There are also more than 30 Observing Program coordinators assisting with the administration of the programs.

Details about all the programs may be found on the Astronomical League website at *www.astroleague.org*. For an overview, see the Observing Programs listing elsewhere in this issue.

Referring to the listing, Mygatt says it's a handy resource for observers to begin "shopping" for programs of interest. However, these are only guidelines, leaving ample room for individuality based on a member's own experience, preferences, or sense of exploration. He adds, "In the end, we just want people to be successful and enjoy themselves."

Observers may work on multiple programs at the same time and take as much time as they require for completion. The details of each program generally follow a similar format: an introduction or overview; documentation on the nature of the objects to be observed; the object list and number of objects to be observed; a requirements section, which includes specifics on maintaining an observing log and other materials; and how to submit observations to the program's coordinator for an award. Members may choose to submit their observations for award certificates and pins, or they may use the program lists purely to put more variety into their observing sessions.

To assist members working the programs as beginning observers, Observing Program director Clevenson maintains handy observing tools on the League website called "What's Up, Doc?" and "What's Up Tonight, Doc?" These resources help members know what objects from various observing lists can be viewed during a current month or evening, removing some of the guesswork involved in preparing for a night under the stars.

The numbered award certificates and pins may be mailed directly to the member or to the member's club coordinator for presentation at a local club meeting. Member names, certificate numbers, and League affiliations are published quarterly in the *Reflector* under "Observing Awards" toward the back of the magazine. Members can also check the status of all their awards in a database maintained on the League website. Award certificates are suitable for framing and make showy wall displays. The award pins are often worn on field gear, and some members have mounted them into attractive shadow box exhibits.

Involving young people in the science of astronomy has been a long-standing priority of the Astronomical League at both the national and local levels. As local clubs explore inventive forms of youth outreach, the League continues its 23-year support for these efforts with award programs directed at encouraging and recognizing outstanding youth accomplishments. Astronomical League vice president Bill Bogardus oversees these programs. "Youth Awards are given to encourage, celebrate and honor those students that pursue the area of astronomy in their educational learning experience." The premier recognition is the National Young Astronomer Award (NYAA) presented annually at Astronomical League conventions.

Youth interest is best nurtured at the local club level by the commitment of adult members willing to share their time and expertise. An example is the Astronomical Society of Long Island, where League programs have helped one teenager discover astronomy and bolster much needed self-esteem. As a youngster, Ethan Maitra was diagnosed with Asperger's and found it challenging to find activities where he feels socially comfortable with others. The club's Thomas Pennino has been mentoring Ethan, and the young observer has derived a great sense of accomplishment through club membership and pride in receiving awards for the Sunspotter and Binocular Double Star Programs. According to Pennino, "Ethan reminds us what we felt when we began observing the many wonders of the heavens."

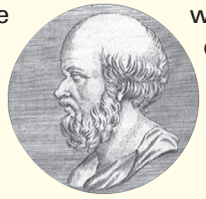
League observers eagerly anticipate the annual introduction of new observing programs. Where do these programs come from? They're created by fellow members with a passion for a particular aspect of observing they wish to share. Cindy Krach of the Haleakala Amateur Astronomers was the lead author, assisted by club members, on the Sketching Program. She had read how sketching would help hone her observing skills. Trying it, she realized much more detail revealed itself when she spent time capturing what she observed as accurately as possible. Particularly when looking at very faint fuzzies, it really hit home to her what a valuable tool sketching becomes in the observing process. She says, "The Sketching Program helps people increase their powers of observation when they slow down long enough to faithfully record what they observe." She quickly adds, "And you absolutely don't have to be an artist!"

Another new program has presented challenges and rewards even for the League's most seasoned observers. The Active Galactic Nuclei Program, authored by Master Observer Al Lamperti of the Delaware Valley Amateur Astronomers, joined programs such as Galaxy Groups and Clusters, **Fl**at Galaxy, and Herschel II that benefit from observer experience, larger apertures and dark skies. According to Lamperti, the purpose of his program is to provide the opportunity to find and detect elusive active galactic nuclei, including quasars, BL Lacertae objects, and Seyfert galaxies. He says his most satisfying personal experience has been splitting lensed quasar QSO B0957+561 in Ursa Major. "Neat to see a dot whose light left seven billion years ago. Quite humbling."

President John Goss has an enthusiastic outlook on the future of amateur astronomy, as well as the personal benefits which result from the social aspects of astronomy clubs. He thinks even though we may have spectacular images at our fingertips, amateur astronomers will always want to see things in real time with their own eyes and personally experience the beauty and mystery of the incredible universe. "More people will desire what I call the 'authentic observing experience,' that is, that special relationship of telescope, observer and sky," Goss says. "The Astronomical League observing programs are an excellent place to find that."

Channeling Eratosthenes

By Dave Furry, Southern Colorado Astronomical Society



Eratosthenes (276 to 194 BC)

Just for fun and to celebrate the summer solstice, I decided to emulate the great Greek geometer Eratosthenes by trying to measure the circumference of the Earth from my backyard in Pueblo West, Colorado!

As the story goes, Eratosthenes asked himself why should a stick in Syene (now Aswan), Egypt cast no shadow at the summer solstice, when far to the north, in Alexandria, there would be a distinct shadow? Eratosthenes correctly surmised that the only way this could happen is if the Earth were curved—otherwise, if the Sun were directly over a flat Earth, there would be no shadows anywhere!

His reasoning was like that shown in Figure 1. He placed a vertical stake in the ground in Alexandria, measured the length of its shadow at a precise time, and calculated its angle by simple trigonometry. The "shadow angle" is the same angle as that subtended by the curvature of the Earth (alternate interior angles are equal—remember 10th grade geometry class?).

I drove a stake in the ground in my backyard (Figure 2) and measured the length of its shadow (Figure 3) at solar noon (the shortest shadow, which occurred just before 1:00 MDT). From the height of the stake I was able to calculate the subtended angle (14.90 degrees, Figure 4). I divided that into 360 degrees and got a factor of 24.16; in other words, I am about 1/24 of the way around the world from where the Sun is directly overhead. Now if I multiply 24.16 times the distance between Pueblo West and the Tropic of Cancer (where the Sun is overhead at the summer solstice and where the shadow angle of the Sun is zero degrees), I would calculate the circumference of the Earth!

At this point, Eratosthenes hired someone to pace off the distance between Syene and Alexandria, but I don't have that level of commitment. I merely consulted my globe and noted that Durango, Mexico, lies near the Tropic of Cancer (where the Sun will be directly overhead on the summer solstice) and is almost due south of my backyard. From my road atlas, I scaled the distance between Pueblo West and Durango at 1,023.5 miles.

Multiplying 1,023.5 miles by 24.16 gave me about 24,730 miles. The actual circumference of the Earth (through the poles) is 24,860 miles, an unexpected error of only 0.5 percent on my first try—no fudging at all, honest! We are not sure of the exact answer Eratosthenes calculated, because no can say for sure how long his length of measurement, the stadia, was. Also, he assumed that Syene (Aswan) was on the same longitude line as Alexandria, but it's not. In any case, though, his theoretical technique was certainly accurate!

This is how science nerds have fun.

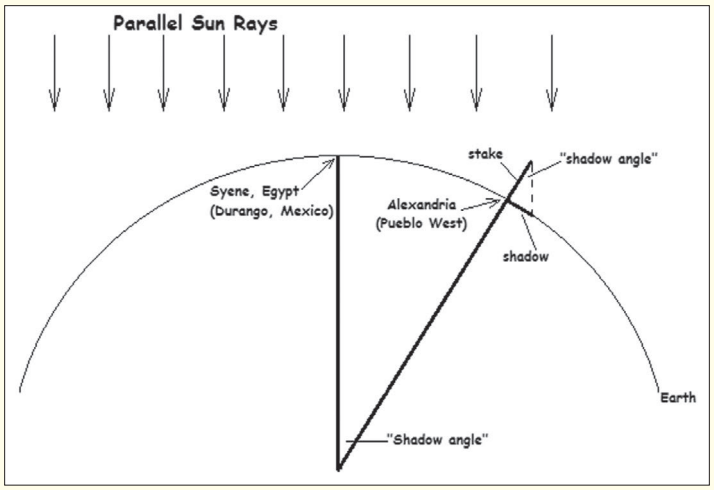


Figure 1: Shadow angle at Alexandria

Figure 2: My "high-tech" setup to measure the Sun's shadow. The concrete block is to prevent movement due to the famous Pueblo West winds.

Figure 3: Measuring the shadow

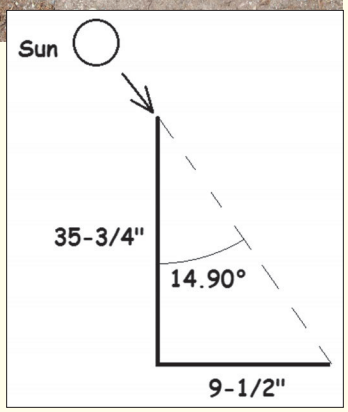


Figure 4: right; Calculating the shadow angle

ALCon 2016/*from page 15*

Skip Bird offered two workshops: "Eclipses and Seasons: Activities and Outreach" and "Energy from the Sun for Families." With AstroCon 2017 in Casper, Wyoming, a year away, this was excellent preparation for outreach around the eclipse.

Vivian White, who traveled all the way from California, set up next year's ALCon perfectly with her workshop "Left in the Light: Preparing Your Community for Viewing a Partial Eclipse in 2017." This was a timely look on how to help others to experience the eclipse safely from wherever they are viewing.

NOVAC's Skip Sufitchi contributed two workshops around his specialty of radio astronomy: "Radio Meteor Echoes" and "Solar Flare Detections." All of these can be achieved in one's own backyard! These outreach-oriented programs were well received and well attended.

In the Vendor's Room

Our vendors and other club and association displays set up in the second side hall at NRECA. These were well visited throughout the three days of ALCon. We had some nice raffle items donated, including a year's subscription to *Astronomy* magazine, five DeLite eyepieces, a planisphere wrist watch, a jumbo Pocket Sky Atlas from *Sky & Telescope* magazine, a $75 coupon from Kendrick Astro Instruments, and a 102 mm Maksutov-Cassegrain telescope from Celestron!

JOE TESSMER

ALCon 2016 chair, David Werth, presents NASA Administrator Bolden a conference cap.

Star-B-Que

D.C. weather in August can be mighty hot, and this summer was no exception, with four days of baking hot temperatures in the high 90s to about 100 degrees. It was something of a relief on Thursday evening to head to nearby Barcroft Park for the annual Star-B-Que.

Beneath the tall trees next to Four Mile Run, attendees were able to cool off, make new friends, and enjoy some fine Virginia barbeque from Red Hot and Blue. We wanted this to be relaxed and fun, so no presentations were offered. As a special treat, music was provided in the open pavilion by The Awesome Exaggerations. With a wide range of music styles and four fine vocalists, the attendees were entertained until well after dark. "Fly Me to the Moon" was a big hit with the ALPO folks!

Youth Award Winners

One of the surprise highlights of ALCon 2016 was getting to meet and listen to the presentations by this year's AL youth award winners. Katie Melbourne, a member of the Popular Astronomy Club in Illinois, who is attending Yale University; Megan Gialluca, a member of the New Hampshire Astronomical Society and a student at the Hollis Brookline High School; Ginger Mellott of the Charlottesville Astronomical Society (can't stop those Virginians!); Jay Senthilvelan, a student at Buchanan High School in Clovis, California; and Swagat Bhattacharyya from Morgantown High School in West Virginia all made a major impact at ALCon 2016.

If you haven't seen it yet, go back and read Bill Bogardus's article in the September 2016 *Reflector* for more details on these impressive young scholars.

Awards Banquet

On Saturday the 13th, the final day of ALCon 2016, after the final guest speaker concluded at

Top: A view of the room during the awards banquet. Bottom: Good food, good company in a pretty park.

ARLEN RAASCH

DAVID WERTH

USNO Public Affairs Officer Geoff Chester led attendees through this historic observatory including its extensive library.

ARLEN RAASCH

The Awesome Exaggerations entertained the ALCon folks until well after dark.

DAVID WERTH

4:30, we had 90 minutes until the awards banquet was to begin. We turned the main hall at NRECA over to the caterers who would convert the room from a conference configuration to a dining room for a buffet dinner. Several people caught me pacing the hallway and said I must be glad this was over. My reply was, "it isn't over until I get a call from the general." The general in question was NASA administrator General Charles F. Bolden, Jr., who was to be our keynote speaker at the awards banquet. Until he arrived, nothing was finished. When I finally got the call on my cell phone and the voice on the other end said, "Hi David, this is Charlie Bolden," my shoulders could finally come down.

When planning the speaking schedule, and particularly Saturday evening's keynote address, we thought, who in Washington would be a home-run speaker? How about the man who runs the U.S. space program—a U.S. Marine for 45 years, a four-time space shuttle astronaut, and NASA administrator since 2009? It took three months to find an approach to the administrator, get a letter to him, and await his response. He is a very busy man and there were no guarantees. When the email came in that General Bolden would attend, you could hear the cheers from Virginia to Kansas City!

Visitors to NASA's Goddard Space Flight Center could witness the James Webb Space Telescope being assembled in the clean room.

BILL BURTON

The original plan for the banquet had the AL and NOVAC leadership with their wives sitting at the head table with General Bolden—perks of the planners! But during the afternoon, NOVAC president Terry Cabell had an idea. Why don't we give up our seats at the head table and have the youth award winners sit with the administrator? I loved the idea—we sought permission from the parents and made it happen.

Watching the animated discussions during dinner between General Bolden and the five award winners, it was clear that this would be a night to remember for all. General Bolden certainly thought so. In a note I received from him after the convention, he wrote, "I really enjoyed the evening—especially the opportunity to talk with the students and learn about their projects. Our future is in great hands!"

The NASA administrator's keynote address was really the highlight of the week for us.

His talk at the awards dinner absolutely blew away the 130 guests in attendance. His humor, keen insights, and humility resonated powerfully with our guests. When he finished, everyone in the room spontaneously stood and applauded. They would have gone on for five or ten minutes but, as emcee, I had to quiet the room down.

The emails I received after the convention all struck the same note—what an inspired speaker and a terrific man he is. He sent the attendees back home across the country with a warm feeling they probably had not expected.

For the Astronomical League members who attended ALCon 2016, thank you! And for those who couldn't make it, you missed a fun time. It took a dedicated team of NOVAC volunteers to pull this off and I wanted to let the entire NOVAC family know how much I appreciate their efforts.

Next year in Casper, Wyoming!

10, 25, and 50 Years of the Astronomical League's Magazine

By Mike Stewart, Astonomical League Historian

February 1967

Amateurs to Peru for Eclipse


REFLECTOR

AMATEURS TO PERU FOR ECLIPSE

The sun shone in all its glory at Arequipa in southern Peru Saturday. It was the perfect answer to the prayers of amateurs from the Detroit Astronomical Society who had traveled 5,000 miles to observe the total eclipse. The 72-second totality, recorded by 11 instruments taking 15 different experimental measurements, was an exciting climax to over two years of preparation by the local group. In semi-darkness the corona was an awe-inspiring moment for the 20 Indians who squatted on the brow of the hill which marked the expedition site. The group of 14 from Detroit, augmented by three from Ohio and three who joined at Miami, was led by Dr. E.J. Love and Richard Lloyd. Success came as an unexpected climax to the local group, beset by mishaps since arriving in South America Nov. 5.

No need to travel 5,000 miles in 2017 to observe a total solar eclipse! Observers in the U.S. likely live within an easy day's drive of the centerline of the August 2017 eclipse.

February 1992

The Great Aurora of 1991


REFLECTOR

The Astronomical League Newsletter

The Great Aurora of 1991

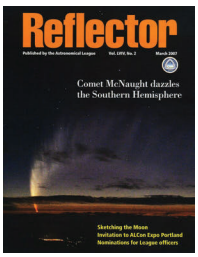
COSMOCON '92 CONVENTION DETAILS

Did you catch the Great Aurora of 1991? On November 8, many parts of the United States enjoyed a rare and spectacular auroral display. This extensive aurora was not only seen in the northern part of the country, as you would expect, but as far south as Texas and New Mexico. Friday night was meeting night for many clubs. But there were several dedicated observers who skipped their meetings to go observing instead and saw the aurora. [T]he most eloquent description of the Chicago sighting came from CAS member Dorothy Nichols. She observed the aurora from her home out in the dark sky country near Apple River Canyon State Park. The show began shortly after 6 PM, she writes, "with greenish-white rays, streaks and eerie brightness throughout the north-northeast portion of the sky. Then came the broad pinkish-red bands which appeared to extend from both east and west toward the zenith, and which gradually shifted southward. These red streaks extended so high that my son could see them through the sun roof in his car as he drove out for the weekend. This phase of the show lasted until well after 7 PM, then faded. We thought the display was ending and went in for dinner. But that was only the beginning. Each time we thought the show was over, the light would return with a new form and motion. Although we saw no more red color, we experienced virtually every manifestation I have ever seen illustrated. There were streaks, arcs, an overall glow, ghostly clouds of light shooting in puffs from high in the north, and finally, perhaps most awesome, a wide set of draperies folded back on itself."

For many observers, the unexpected appearance and observation of an aurora in the continental U.S. remains an uncommon and treasured memory. Aurora-alerting apps increase the chances of seeing aurora when they drift far south of their normal latitudes.

March 2007

Crayon Moon


Reflector

Comet McNaught dazzles the Southern Hemisphere

Sketching the Moon

Invitation to ALCon Expo Portland

Nominations for League officers

I have sketched, drawn, and painted for most of my life, and I have had a love affair with the night sky for as long as I can remember. It is only in the last two years that I have combined both these interests into a new adventure. This came about by the example and encouragement of a dear friend. She introduced me to the absorbing passion of astronomical sketching. This activity has given me an outrageous amount of pleasure and learning. I have discovered that to achieve a good sketch, you must look at what you want and not only observe it but also absorb it. You must make a mental note of your target, and bring it from the subject through the eyepiece to your paper...

Sketching is the best, most intense way to learn the Moon. The ever-changing symphony of shadows and light are a joy to observe and reproduce. Deirdre Kelleghan of the Irish Astronomical Society contributed this fine article on sketching the Moon. Her article captured the enjoyment of observing and sketching at the eyepiece. Like Dierdre's article, the Astronomical League's Sketching Observing Award encourages us to slow down the observing process and improve observing skills over time. As with anything, practice will improve the ability to recreate what is observed in the eyepiece.

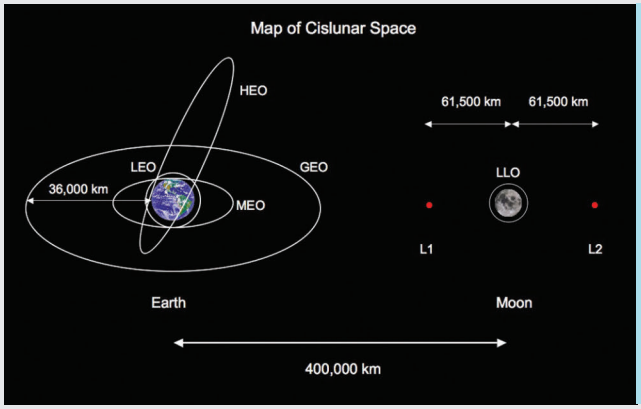
Using Two Moons to Make "Mars Direct" Sustainable

By Al Anzaldua and Dave Dunlop

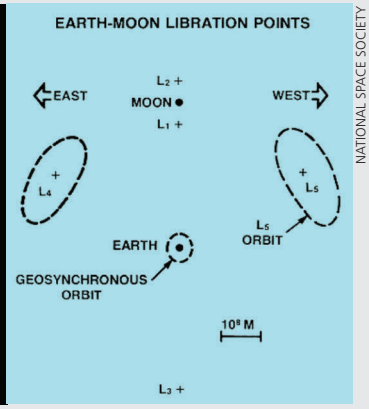
Background

In September 2016, amid great fanfare at the 67th annual International Astronautical Congress in Guadalajara, Mexico, SpaceX CEO Elon Musk described his plan to build a civilization on Mars. His plan involves developing a range of new technologies: enormous reusable rockets, gigantic carbon-fiber fuel tanks, ultra-powerful rocket engines, and spaceships capable of carrying a hundred or more passengers simultaneously to the planet, then repeatedly returning to Earth to pick up more.

Musk is not the first person to boldly propose skipping a Moon base or cislunar infrastructure to settle Mars directly. For instance, in 1996, Dr. Robert Zubrin proposed a "Mars Direct" approach to settling humans on the Red Planet. Although his proposal is modest compared to Musk's, Zubrin's *The Case for Mars* book nevertheless outlines a step-by-step method to send humans to Mars within ten years to begin settlements there.



SPUDIS LUNAR RESOURCES

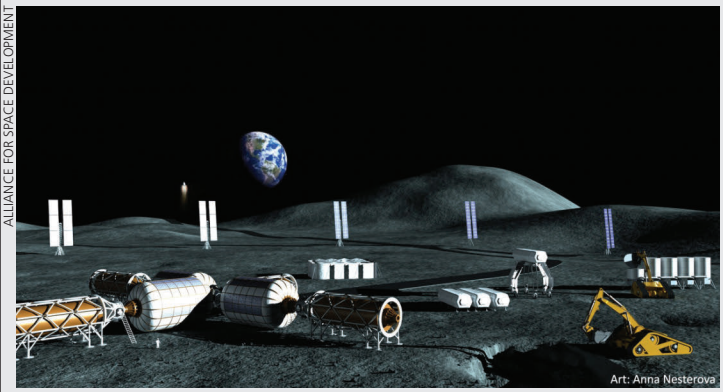


NATIONAL SPACE SOCIETY

Critics of Musk, of Zubrin, and of other "Mars Direct" advocates have pointed out that any settlement on Mars could end with tragic loss of life without an adequate supply chain and a transportation, communications, and energy infrastructure connected to the Moon and its cislunar spaces. As part of such infrastructure, several authors have proposed in-situ resource utilization (ISRU) of lunar resources, including water, metals, and building materials, as a stepping-stone to developing and settling Mars.

One vision for ISRU-supported infrastructure involves placing propellant depots in low Earth orbit (LEO) and in "halo" orbits around Earth-Moon Lagrange point 2 (E-M L_2) to refuel in-space ferries and tankers, carrying people, supplies, and fuel to and from various inner solar system destinations. While the propellant for LEO depots would be supplied from Earth at first, propellant for subsequent LEO depots and E-M L_2 depots would come from water ice found in cold traps inside polar lunar craters.

Energy and communications infrastructure, on the other hand, would be supplied by networks of solar arrays and communications equipment on the lunar surface and in various orbits around the Earth and Moon. Although food and other supplies for human maintenance could at first be supplied from Earth via cycling in-space ferries, solar system pioneers would eventually have to produce their own food and recycle water, nutrients, and vital gases with bioregenerative systems.



ALLIANCE FOR SPACE DEVELOPMENT

A concept of a base at the lunar poles, mining water ice to turn into propellant. Such a base could be developed for $40 billion by leveraging public-private partnerships, according to a new study.

Rethinking Mars Settlement via Two Moons plus the Mons Volcanoes

First Step: Integrate ISRU into Cislunar/Lunar-Surface System

Scientists, engineers, and architects have proposed various technologies and systems for extracting volatiles, metals, and various elements from lunar regolith, while simultaneously producing building materials. In this context, a new lunar regolith processing technology developed by Dr. Peter Schubert shows promise. His "Lunar Factory for LOX and Metals" consists of two previously independent solar-powered inventions combined to form an integrated factory for processing regolith into useful products, such as oxygen for life support and propellant, as well as silicon, iron, aluminum, titanium, and slag for construction and additive manufacturing. Such ISRU products would greatly increase lunar and cislunar self-sufficiency, while giving solar system pioneers experience for extracting resources from other celestial bodies, such as minor moons and asteroids.

Second Step: Utilizing Deimos ISRU

As a potential source of ISRU, Deimos is a particularly tempting target. It is energetically easier to reach Deimos from LEO than from the lunar surface. At around 20,000 km from the martian surface, telerobotics from Deimos would be very near real-time. Even better, because Deimos orbits just above Mars-synchronous orbit (MSO), from the perspective of Deimos, Mars would appear to slowly rotate eastward at only 2.7 degrees per hour, thus offering a generous line-of-sight telerobotics time, unavailable from Phobos. Over a period of about five and a half days, strategically placed telerobot operators on Deimos would be able to explore and work across all of Mars, except for extreme polar regions.

Using Deimos as a natural resource goes far beyond it being an ideal telerobotics platform. Measuring 15 x 12.2 x 10.4 km, Deimos is much bigger than the near-Earth asteroids NASA is considering visiting at considerable expense. Yet the escape velocity from Deimos would still only be 5 meters per second, making it a fuel-sparing staging platform for solar system transit. In addition,

several meters of Deimos regolith between a Deimos-based crew and interplanetary space would provide shelter from cosmic radiation.

Better still, both Deimos and Phobos appear to have the characteristics of dark carbonaceous asteroids, with assemblages of anhydrous silicates, carbon, organic compounds, hydrated minerals, and water ice. If this carbonaceous composition bears out, the regolith of Deimos could provide water and other volatiles for life-support and propellant. Deimos-sourced propellant could power reusable ferries and tankers from Deimos to various solar system destinations and back.

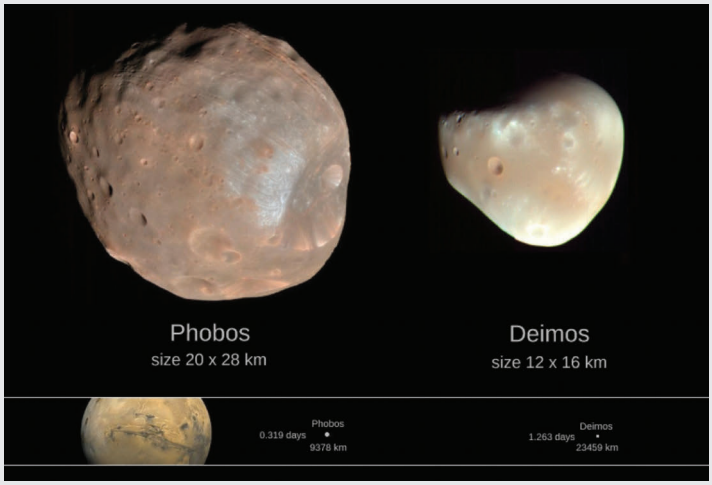
The regolith of Deimos will also likely contain silicates, metals, and other valuable materials for construction and manufacturing. Deimos is an accessible orbiting "platform" already in place and readily accessible for staging, communications, Mars telepresence, and developing asteroid mining technologies. Because the intensity of sunlight reaching Mars and its moons Phobos and Deimos (Mars PhD) is less than half that reaching the Moon, powering a Schubert-type regolith separator will be harder, but not impossible. Luckily, Deimos does not have a light-scattering atmosphere and dust storms like Mars. Adequately large solar panels could therefore be constructed to power the regolith resource-extractor.

Deimos would be the best ISRU site for a Mars orbital complex, Mars settlement, and further solar system expansion. Telerobotics, oxygen and water for life support, vehicle staging and fueling, shelter from cosmic radiation, and construction and manufacturing materials would all be provided by Deimos.

Third Step: Basing On and Near the Mars Mons Volcanoes

Why the Mons volcanoes? Effective Mars surface exploration will require a phased strategy to access shelter and natural resources for

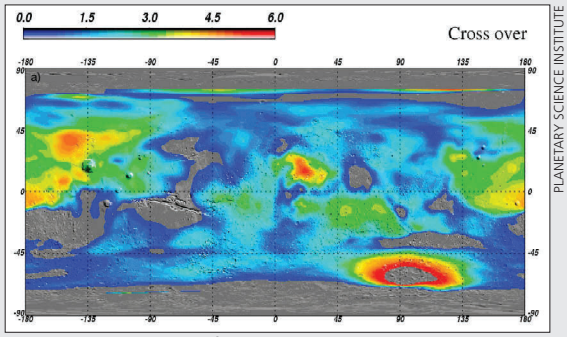
AD ASTRA



life support and for fabrication and construction. In this regard, the western slopes and bases of the basaltic shield volcanoes Elysium Mons and Olympus Mons would be excellent sites to initiate permanent human habitation. These shield volcanoes are laced with many cubic miles of lava tubes, likely containing useful frozen volatiles and minerals. Because these natural caverns have roofs estimated to be tens of meters thick, human habitats would be protected from solar radiation, micrometeoroids, extreme temperature fluctuations, winds, and dust storms that would pose a threat to human health and technology. Moreover, if life exists on Mars, a compelling place to look for it would be within a sheltering lava tube or cave.

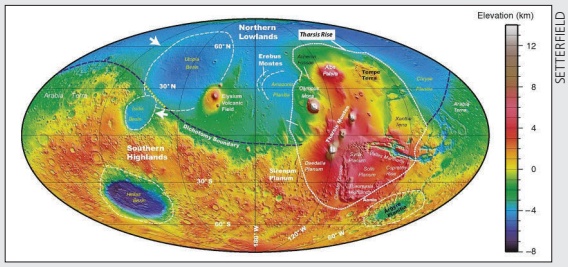
Judging from lava tubes on Earth, the potential yields for science, life support, and infrastructure development on both the Moon and Mars would be significant. Moreover, our experience exploring the lava tube environments on the Moon would advance settlement strategies for Mars. The Moon could therefore be a major engineering on-ramp for the practical experience of exploring and modifying lava tubes on Mars for habitation.

Yet there is another practical reason for establishing human presence on the western flanks, particularly at the base of these gigantic shield volcanoes: water! Aside from the likely frozen water we are likely to find in martian lava tubes, scientists have discovered evidence of vast ice deposits to the west of both Elysium Mons and Olympus Mons at a depth in some places of less than a meter. For example, just under the surface of Utopia Planitia to the west of Elysium Mons exists an ice reservoir larger than New Mexico and containing as much water as Lake Superior. Also, the western slopes of both Olympus Mons and Elysium Mons plunge to below the datum—that is, zero elevation. At a given latitude, these lower-elevation areas have relatively higher temperatures and atmospheric pressures, and thus are more conducive to human habitation.



PLANETARY SCIENCE INSTITUTE

Dr. William Feldman of the Planetary Science Institute in 2012 analyzed data from NASA's Mars Odyssey neutron spectrometer and found evidence of large amounts of water ice just beneath the surface (more than 4.5 percent of water-equivalent hydrogen in orange and red areas).



SETTERFIELD

Lava tubes are also associated with the Tharsis Montes equatorial volcanoes: Ascraeus Mons, Pavonis Mons, and Arsia Mons. However, the Tharsis bulge on which they are located is not connected to any large water ice deposit. Still, if significant amounts of water could be found within the lava tubes that run down from the Tharsis volcanoes into the low-lying eastern portion of Noctis Labyrinthus, human habitations could also be established in that region.

Regarding mission sequencing, the appropriate resource-extractors and systems could begin robotically producing water, oxygen, propellant, metals, and other fabrication materials before humans arrive on the Moon, Deimos, and Mars. Because solar energy reaching Mars's surface is only 44 percent of that reaching Earth's, Schubert-type element separators would require very large solar arrays. Yet even large arrays would be inadequate during martian dust storms. Energy production on Mars would therefore require supplementation by nuclear reactors.

Conclusions and Summary

A long-term commitment to an Antarctic-style research station will not do. For self-sufficiency and sustainability, the selling of goods and services must be an integral part of the settlement mix. Tourism will undoubtedly be one of the first services that companies will provide for profit. Mining of water and mineral resources will run a close second. Eventually, refined goods and sophisticated

Continued on page 25

FROM AROUND THE LEAGUE

(left to right) Terry Trees, MERAL Chair; John Goss, AL President; Tom Reiland, Director of the Wagman Observatory (and the first recipient of the Herschel 400 Observing Program certificate); and Becky Nichols, director of the Mingo Observatory

It's Been 50 Years of Observing Programs!

On Friday evening, January 13, 2017, the Astronomical League and the Mid-East Region presented the Amateur Astronomers Association of Pittsburgh with two special plaques commemorating the very first Observing Program certificate awarded fifty years earlier. On that night in 1967, AAAP President RC Dickensen presented observer Catherine Delaney her certificate in the newly launched AL Messier Observing Program. Since then, nearly 3,000 Messier Observing Program certificates have been earned by AL member observers.

Solar Eclipse 2017 Special Award

August 21, 2017, should be on your calendar. Over the course of 94 minutes, the shadow of the Moon will pass from Oregon to South Carolina. All of the continental U.S. will experience at least a 60 percent partial eclipse, but to see totality, you will need to travel to the path.

The Astronomical League will be offering a Special Observing Award certificate and pin to those who are up to the challenge. There will be general certificates for the public as well. The goal of the Special Observing Award is to follow in the footsteps of astronomers of the past and to attempt to calculate the effect of the Sun's gravity on the path of the photons coming from stars close to the edge of the Sun.

This is an experiment that was done to test Einstein's general theory of relativity. The deflection of starlight near the edge of the Sun is expected to be less than about 2 arcseconds. Instructions and requirements will be posted on the AL website soon. You may use your own images or images from the Internet.

Aaron Clevenson, *Coordinator, Solar Eclipse Special Observing Award*

Call for League Officer Nominations

The two-year term of the office of secretary ends on August 31, 2017. If you are interested in using your talents to serve in this important position, we would like to hear from you. Please volunteer!

For specific information regarding the duties and responsibilities of this office, please refer to the League's bylaws, which can be accessed on the League website at *www.astroleague.org*.

Each candidate should send a statement explaining why they are interested, along with a photo of themselves for publication in the *Reflector*, to nominating committee chair Bill Bogardus, *vicepresident@astroleague.org*. Please limit all statements to approximately 250 words. All nomination materials must be submitted by March 15, 2017.

A New Astronomical League Program: The Astronomical League–OPT Imaging Awards

Oceanside Photo and Telescope has always been a good friend to amateur astronomy and to the Astronomical League. They have now enthusiastically offered to sponsor a new AL award program, the OPT Imaging Awards.

The AL recognizes the efforts of imagers with a program where they can submit their best work in four categories:

1. **Solar System Award:** featuring the Moon, Sun, planets, or comets
2. **Deep-Sky Award:** showing star clusters, nebulae, or galaxies
3. **Wide-Field Award:** capturing constellations, the Milky Way, aurorae, meteors, or planetary conjunctions and groupings
4. **Video/Time-Lapse Award:** showing movement in the heavens

Each category will have a first, second, and third place. First-place winners will each receive a $250 gift certificate from **Oceanside Photo and Telescope**, second place winners will each receive a $125 gift certificate, and third place winners will each receive a $75 gift certificate.

Please see *www.astroleague.org/al/awards/awards.html* for complete details of this exciting new program!

The Astronomical League–Astronomics Sketching Award

Sketching the impression of a celestial scene allows the observer to see more detail and to better enjoy our amazing avocation. Why not try your hand at sketching tonight?

The Astronomical League is administering a new award program, the Astronomics Sketching Award. First place sketcher receives a cash prize of $250, second place $125, and third place $75!

For all the exciting details, please visit the Astronomical League awards page, *www.astroleague.org/al/awards/awards.html*.

This program is made possible through the vision and generosity of Astronomics, *www.astronomics.com*!

2017 Mabel Sterns Newsletter Editor Award

The **Mabel Sterns Newsletter Editor Award** recognizes the work of Astronomical League club newsletter editors across the country. The deadline for nominations is quickly coming to a close on April 1, 2017 (no fooling). Nominations from the president or vice president of an Astronomical League–affiliated club should explain why their newsletter editor should be considered for the award.

Please email entries to *SternsNewsletter@astroleague.org*. The nomination should include:

- Name and postal address of the newsletter editor
- A recent issue of the newsletter in Adobe PDF or a link to it
- A photo of the editor, preferably in an astronomical setting (JPEG, please)
- URL of the club's website where electronic copies of recent newsletters are posted (along with any necessary passwords) would be welcome and helpful
- Name and city of the club

Both the nominating officer and newsletter editor must appear on the AL roster.

If electronic submission is not possible, four (4) paper copies of the letter of recommendation and newsletter may be mailed to the League's national office. One photo is sufficient.

2017 Webmaster Award

The time is now. The deadline for submissions for the Astronomical League's Webmaster Award is April 1, 2017 (no fooling).

The Webmaster Award recognizes the effort of those individuals who produce the vibrant, informative websites that are so essential to the growth and vitality of astronomy clubs. Each year the League presents the Webmaster Award to the webmaster of the best club website. A website is an important asset for any astronomy club, and this award acknowledges the winning webmaster's outstanding job of website design and administration. Websites are judged on:

- Technical and visual design and organization
- Content, including club activities, club calendar, educational content, and links
- Outreach
- Administration and timeliness of content

Club presidents are asked to send webmaster nominations and the club's website address, no later than April 1, 2017, to *webmasteraward@astroleague.org* or to Mike Rao, Astronomical League Webmaster Award Administrator, 2328 Naomi Street, Houston, TX 77054.

Candidate Statement: Office of Secretary—Bryan Tobias

I have been an amateur astronomer for well over 40 years, since I began looking at the Texas sky when I was five years old during the days of Apollo. I have been fortunate in my life, being able to experience many things in the aviation field as a pilot and technical advisor, another passion of mine. I have since decided to return to school full time and work towards a PhD in astrophysics to begin professional work as an astronomer and educator while managing the university's observatory and public outreach programs.

I was chairman of the San Antonio Astronomical Association from 2003 to 2009 and a founding member of the San Antonio League of Sidewalk Astronomers (SALSA) from 2009 to present. In 2003 I was instrumental in the formation of the "Astronomy in the Park" program that takes place every Wednesday evening in a local park here, and it continues to take place today after 12 years of success. Another accomplishment that I am very proud to be part of is the implementation of the Texas Amateur Astronomers' Scholarship to the University of Texas at Austin's Astronomy Department. In January of this year we reached full endowment status for the scholarship and the first award to a deserving astronomy student will take place later this year. In 2017, I begin my fourth year as coordinator of the Astronomical League's Solar System Observers Program, and it has been an absolutely wonderful experience communicating with all who have applied for the award, sharing knowledge and experiences. This is only a small part of my experience of leadership and involvement in astronomy, and I would be extremely honored and humbled to continue to serve you as Secretary of the Astronomical League.

The Astronomical League is Giving Away up to Ten Library Telescopes!

Through the vision of the Horkheimer Charitable Fund, the Astronomical League is again offering a free Library Telescope to a lucky Astronomical League club in each of the ten AL regions. This wonderful program consists of an Orion 4.5-inch StarBlast Dobsonian (or equivalent), a Celestron 8–24 mm zoom eyepiece (or equivalent), and a name plate commemorating the late Jack Horkheimer. The value of this opportunity is approximately $300; the potential of the program is enormous.

The Library Telescope Program was initiated by the New Hampshire Astronomical Society. Clubs donate an easy-to-use, portable telescope with quality optics and a sturdy mount to their local library. Patrons can then check it out as they do books. Full details of this wonderful program can be found at *www.astroleague.org/content/library-telescope-program*.

The winning entry for each region will be announced at the annual Astronomical League Business meeting held at ALCon/AstroCon 2017 in Casper, Wyoming, on about August 18. Only one club per region will win for a total of ten telescope–eyepiece combinations being presented. The telescope, eyepiece, and accompanying commemorative plate will be mailed to the winning clubs in the weeks following ALCon.

By entering the drawing for the telescope, the club agrees to modify the telescope and zoom eyepiece, and have the telescope library-ready within three months of receipt. The Astronomical League would like a photograph of the modified telescope being presented to the library.

The photo may be used in the *Reflector* and may be used at some point as promotional material.

Submit your completed entry form, found at *www.astroleague.org/files/library_telescope/2017%20Horkheimer%20LiTel%20entry%20form.pdf*, so that the Astronomical League national office receives it by July 31, 2017. If mailed, the entry must be postmarked no later than July 31, 2017.

The Library Telescope Program is a great club project, one that brings members together while benefiting their community. Indeed, it is the perfect outreach program!

Celestial Savings Program—Your Discount Purchasing Program

The Astronomical League is excited to announce its new **Celestial Savings Program** where all League members qualify for special discounts at participating vendors when purchasing equipment, accessories, or books. Please note that discount amounts may vary by vendor and by items purchased.

See the Celestial Savings Program ad included in this issue of the *Reflector* to determine participating vendors.

If you are a current AL member, you may obtain the discount codes by first logging into your AL member account. If you do not already have an account (your member account is separate from your store account) you may obtain one by visiting

Continued on page 27

Two Moons/*from page 23*

services will evolve. A "Two Moons to Mars Mons" strategy could rapidly extend engineering, technological, and commercial advances from the Moon and cislunar spaces to the Mars PhD system, greatly facilitating sustainable solar system development for the benefit of humankind.

Al Anzaldua, a long-time space advocate and former U.S. diplomat, has held leadership positions in NSS and has published a series of articles on space development.

David Dunlop is a long-time member of NSS and current chair of the NSS International Committee.

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Gallery

Jeffrey O. Johnson, with the Astronomical Society of Las Cruces, sent this image of IC 2177, the Seagull Nebula. He used a Takahashi FS-60C telescope at f/6.2 and Em-200 Temma II mount with a QSI 540wsg camera at –15 degrees Celsius.

TITLE PHOTO: NGC 2244; BRIAN KIMBALL

NGC 6992, the Eastern Veil Nebula, is a supernova remnant in the constellation Cygnus. The nebula is a diffuse cloud of heated and ionized gas and dust from a supernova explosion about 5,000 to 8,000 years ago. The nebula is located approximately 1,470 light-years distant, is around 100 light-years across, and was discovered by William Herschel on September 5, 1784. Michael Pusatera from the Astronomical Society of Eastern Missouri imaged this on September 2 and 3, 2016, from Lake St. Louis, Missouri.

Jaspal Chadha of the United Kingdom submitted this nice image of the Horsehead Nebula, Barnard 33, in Orion. The data were collected with an FSQ-106EDX III, QSI 683wsg, and Lodestar on an Astro-Physics Mach1GTO. All filters are Astrodon E-Series Tru-Balance. Image Acquisition by Lloyd Smith at Deep Sky West Remote Observatory and processing by Jaspal Chadha.

The Rosette Nebula (Caldwell 149) imaged by Don Reed of the Von Braun Astronomical Society in Huntsville, Alabama, using a Celestron C11 Edge with HyperStar at f/2 and Atik 490EX color camera. Mosaic of two images, each 10 x 10-minute exposures, processed using MaxIm DL and Photoshop CS2.

All Things Astronomical/*from page 8*

"We looked for evidence of aqueous alteration through other geochemical means and didn't find it," he said.

The geography of the region has many shield volcanoes that are similar to the ones found in Hawaii. However, from geochemical analyses, the researchers found that the sulfur that is present was most likely deposited as a volcanic ash. Volcanic ash from various areas could be evidence of explosive volcanism on Mars, which would be an important clue for piecing together the history of Mars. It is significant because explosive eruptions emit a lot of gas that can stay in the atmosphere and can cause global cooling and warming events.

"Whether there was explosive volcanism on Mars and how much of it there was is an important question in terms of finding out what the past climate was like," Hood said.

From Around the League/*from page 25*

http://members.astroleague.org/request_account and entering your email address. An email will be sent to you with instructions describing how to create an account.

Once you have an account established and log in to the AL website, you should select the "Members Website" tab. Next, click on "Celestial Savings." You will then see a listing of the participating vendors, the discounts they offer for their products, their current discount code numbers, their website URLs, and, if appropriate, telephone numbers. Simply provide the appropriate discount code number to the vendor's salesperson or include it in your website order.

We encourage you to share the existence of the Celestial Savings Program with your astronomy friends, AL members or not. However, please do not share discount codes with anyone.

You're not an AL member? Contact an AL member astronomy club in your area and join through them. You'll find AL dues to be very reasonable, and many local clubs pay them for you.

The Astronomical League also has a member-at-large program detailed at *http://www.astroleague.org/al/general/memblarg.html*.

For additional AL membership details and benefits, visit www.astroleague.org and click the "Join" tab.

Questions? Write to the Celestial Savings director at *celestialsavings@astroleague.org*.

Want to Volunteer?

To maintain the quality of the AL's quarterly magazine, the *Reflector*, we are expanding. Two volunteer positions are available, and if you really want to assist the Astronomical League, this is a great way to start.

We are seeking an editor, who will be responsible for consolidating the necessary data for each quarterly issue. The ideal candidate should have some publishing experience and familiarity with Adobe InDesign and Photoshop and Microsoft Word and Excel. Typical time required is 30 to 40 hours per quarter.

We are also looking for a photo editor, who will collect and review the hundreds of images we receive for each issue, and select the front cover, back cover, and Gallery photos. Experience with Photoshop and Word is preferred.

If you are interested in either position, please contact the managing editor, Ron Kramer, at *http://managingeditor@astroleague.org* with a brief description of your experience as it relates to the position.

For those of you who are not aware of it, the Astronomical League is now on Facebook. We continue to build followers week by week, and we are becoming better known as the word spreads. We are also on Twitter: *@AstronomyLeague.*

Editor's Note: Congratulations to all these outstanding astronomical observers! All awards, except the Herschel 400, require current Astronomical League membership for eligibility. If you have questions about an award, please contact the corresponding Observing Program chair. Their contact information can be found on the Observing Program website at *www.astroleague.org/observing*. If further assistance is required please contact either of the national Observing Program coordinators.

Observing Awards

Active Galactic Nuclei Program
No. 10-V, Michael A. Hotka, Longmont Astronomical Society; No. 11-I, Stephen A. Tzikas, Northern Virginia Astronomy Club

Advanced Binocular Double Star Observing Program
No. 16, Anthony J. Kroes, Neville Public Museum Astronomical Society

Analemma Observing Program
No. 14, Seth Watts, Regular, Member-at-Large

Arp Peculiar Galaxies Northern Observing Program
No. 85-V, Paul Harrington, Member-at-Large

Arp Peculiar Galaxies Southern Observing Program
No. 11-I, Anthony Kroes, Neville Public Museum Astronomical Society

Asterism Observing Program
No. 37, Jeff Hoffmeister, Olympic Astronomical Society; No. 38, Raymond B. Howard, Patron Member; No. 39, Rodney R. Rynearson, St. Louis Astronomical Society

Asteroid Observing Program
No. 53, William Conner, Gold, Indiana Astronomical Society; No. 54, Raymond B. Howard, Gold, Patron Member; No. 47, Marie Lott, Regular, Atlanta Astronomy Club

Binocular Double Star Observing Program
No. 114, Vince Tramazzo, Member-at-Large; No. 115, Lisa Wentzel, Twin Cities Amateur Astronomers; No. 116, Rodney R. Rynearson, St. Louis Astronomical Society; No. 117, Gerard J. Jones, Minnesota Astronomical Society

Binocular Messier Observing Program
No. 1095, Stephen Andrews, Kern Astronomical Society; No. 1096, Seth Watts, Member-at-Large; No. 1097, Katarina Holmquist, Member-at-Large; No. 1098, Jerelyn Ramirez; Kansas Astronomical Observers; No. 1099, John Wheeler; The Albuquerque Astronomical Society; No. 1100, Jim Dixon; Central Arkansas Astronomical Society; No. 1101, Robert Primeaux, Austin Astronomical Society; No. 1102, Mark Colwell, Member-at-Large; No. 1103, Raymond B. Howard, Patron Member

Binocular Variable Star Observing Program
No. 14, Bill Sanders, Central Arkansas Astronomical Society; No. 15, John H. McCammon, Member-at-Large; No. 16, Peter Detterline, Member-at-Large; No. 17, Stephen A. Tzikas, Northern Virginia Astronomy Club

Carbon Star Observing Program
No. 74, Bill Geertsen, Southwest Florida Astronomical Society; No. 75, Kevin McKeown, The Albuquerque Astronomical Society; No. 76, Kevin Carr, Minnesota Astronomical Society; No. 77, John R. "Sean" Sayers, Member-at-Large; No. 78, James Pryal, Seattle Astronomical Society

Comet Observing Program
No. 88, Charlie Webster, Silver, Member-at-Large; No. 89, Stephen A. Tzikas, Silver, Northern Virginia Astronomy Club; No. 90, Mark Simonson, Silver, Everett Astronomical Society; No. 35, Dan Crowson, Gold, Astronomical Society of Eastern Missouri

Constellation Hunter Observing Program (Northern Skies)
No. 179, Ethan Karn, Member-at-Large; No. 180, Stephen Jones, Houston Astronomical Society; No. 181, Al Lamperti, Delaware Amateur Astronomers; No. 182, Vincent Giovannone, Member-at-Large; No. 183, Alex McConahay, Pomona Valley Amateur Astronomers; No. 184, Mark Colwell, Member-at-Large; No. 185, Stephen L. Snider, The Albuquerque Astronomical Society

Constellation Hunter Observing Program (Southern Skies)
No. 9, Mike Hotka, Longmont Astronomical Society

Dark Nebulae Observing Program
No. 23, Lisa Judd, Denver Astronomical Society; No. 24, Mike Stewart, Astronomical Society of Kansas City

Dark Sky Advocate Observing Award
No. 9, Mark Simonson, Everett Astronomical Society; No. 10, John Jardine Goss, Roanoke Valley Astronomical Society

Deep Sky Binocular Observing Program
No. 384, Mark Jones, St. Louis Astronomical Society; No. 385, David Furry, Southern Colorado Astronomical Society; No. 386, John Glover, Northern Virginia Astronomy Club

Double Star Observing Program
No. 591, Charlie Webster, Member-at-Large; No. 592, Tim Hunter, Lifetime Member, Tucson Amateur Astronomy Association; No. 593, Alan Sheidler, Popular Astronomy Club; No. 594, Gerard J. Jones, Minnesota Astronomical Society; No. 595, Rob Torrey, Houston Astronomical Society

Flat Galaxy Observing Program
No. 29, Honorary, Stephen A. Tzikas, Northern Virginia Astronomy Club

Globular Cluster Observing Program
No. 296-V, Bill Geertsen, Southwest Florida Astronomical Society; No. 297-V, Gerard J. Jones, Minnesota Astronomical Society; No. 298-V, Rodney R. Rynearson, St. Louis Astronomical Society; No. 299-V, Steven Sauerwein, Boise Astronomical Society; No. 300-V, Robert Hoover, Huachuca Astronomy Club; No. 301-I, David Venne, Minnesota Astronomical Society

Herschel 400 Observing Program
No. 562, Valorie Whalen, Atlanta Astronomy Club; No. 563, Lauren Gonzalez, Austin Astronomical Society; No. 564, Barbara Biever, Rancho Bernardo/Murrieta Astronomical Society; No. 565, Steve Goldberg, Houston Astronomical Society; No. 566, Kevin Nasel, Neville Public Museum Astronomical Society; No. 567, Denny Henke, Eastern Ozarks Astronomical Society; No. 568, Ryan Behrends, Hill Country Astronomers; No. 569, Gerard J. Jones, Minnesota Astronomical Society; No. 570, Tom Gazzillo, ChesMont Astronomical Society; No. 571, Dan Crowson, Astronomical Society of Eastern Missouri

Hydrogen Alpha Solar Observing Program
No. 34, Carol Smith, Boise Astronomical Society; No. 35, Paul Harrington, Member-at-Large

Lunar Observing Program
No. 968, Linda Claire Freeman, Umpqua Astronomers; No. 969, Ben Adlof, Shoreline Amateur Astronomical Association; No. 970, Alan Rutter, Flint River Astronomy Club; No. 971, Vincent Giovannone, Member-at-Large; No. 972, Glen Fitzgerald, Texas Astronomical Society of Dallas; No. 973, Jerelyn Ramirez, Kansas Astronomical Observers; No. 974, Mark Colwell, Member-at-Large; No. 975, Mike Booth, Minnesota Astronomical Society; No. 976, Lisa Wentzel, Twin City Amateur Astronomers

Lunar II Observing Program
No. 78, Ken Boquist, Popular Astronomy Club; No. 79, Rodney R. Rynearson, Saint Louis Astronomical Society; No. 80, Marilyn Perry, Member-at-Large

Messier Observing Program
No. 2748, Dwight A. Larsen, Honorary, Olympic Astronomical Society; No. 2749, Lisa Wentzel, Honorary, Twin City Amateur Astronomers; No. 2750, Michel Dellepere, Honorary, Member-at-Large; No. 2751, John Wenskovitch, Honorary, Amateur Astronomers Association of Pittsburgh; No. 2752, Richard Luecke, Honorary, Member-at-Large; No. 2753, Jim Dixon, Honorary, Central Arkansas Astronomical Society; No. 2754, Preston Pendergraft, Honorary, Member-at-Large; No. 2755, Tim Livingston, Regular, Oklahoma City Astronomy Club; No. 2756, Marilyn Perry, Regular, Member-at-Large

Meteor Observing Program
No. 61, Vincent Giovannone, Honorary, Member-at-Large; No. 183, Mark Colwell, 6 hours, Member-at-Large

Master Observer (Progression)
Observer Award: Al Lamperti, Delaware Valley Amateur Astronomers; Paul Harrington, Member-at-Large; Paul Morgan, Umpqua Astronomers; Nina Chevalier, San Antonio League of Sidewalk Astronomers; Jake Hairrell, Minnesota Astronomical Society; John Sparks, Knoxville Observers; Mike Ramirez, Northeast Florida Astronomical Society; Alex McConahay, Pomona Valley Amateur Astronomers

Advanced Observer Award: Al Lamperti, Delaware Valley Amateur Astronomers; Rodney R. Rynearson, Saint Louis Astronomical Society

Master Observer Award: No. 191, Alex McConahay, Pomona Valley Amateur Astronomers; No. 192, Mark Bailey, Member-at-Large

Master Observer Award–Silver: Al Lamperti, Delaware Valley Amateur Astronomers; Mark Simonson, Everett Astronomical Society

Master Observer Award–Gold: Al Lamperti, Delaware Valley Amateur Astronomers

Open Cluster Observing Program
No. 78, William Skelley, Tallahassee Astronomical Society; No. 79, John Laning, Member-at-Large; No. 80, Rodney R. Rynearson, Saint Louis Astronomical Society

Outreach Observing Award
No. 67-M, W. Maynard Pittendreigh, Brevard Astronomical Society; No. 474-M, Eddie Agha, Astronomical Society of Eastern Missouri; No. 585-S, Jan Gustafson, Popular Astronomy Club Quad Cities; No. 691-S, Sharon Flemings, Temecula Valley Astronomers; No. 745-S, Amelia Goldberg, Houston Astronomical Society and Fort Bend Astronomy Club; No. 759-S, Steve Goldberg; Houston Astronomical Society and Fort Bend Astronomy Club; No. 760-O, Joe Khalaf, Houston Astronomical Society; No. 765-O, Dan A. Chrisman, Jr., Roanoke Valley Astronomical Society; No. 766-O, Jim Sommer, San Bernardino Valley Amateur Astronomers; No. 767-O, Stephen H. Rand, New Hampshire Astronomical Society; No. 768-M, Jason Wallace, Richland Astronomical Society; No. 769-O, David Downs, The Albuquerque Astronomical Society; No. 770-S, Brian Chopp, Neville Public Museum Astronomical Society; No. 775-S, Christy Wallace, Richland Astronomical Society; No. 776-O, Melissa Wallace, Richland Astronomical Society; No. 777-M, Marc Stowbridge, New Hampshire Astronomical Society; No. 778-S, Matt Lochansky, Raleigh Astronomy Club; No. 834-O, Carolyn H. Chrisman, Roanoke Valley Astronomical Society; No. 835-O, Linda Thoman, Atlanta Astronomy Club; No. 836-O, Raymond L. Bradley, Roanoke Valley Astronomical Society

Planetary Nebula Observing Program
No. 1, Michael A. Hotka, Advanced Southern, Longmont Astronomical Society; No. 10, Brandon D. Jordan, Imaging, Member-at-Large; No. 11, John Skillicorn, Imaging, Tucson Amateur Astronomy Association; No. 31, Jonathan L. Schuchardt, Basic, Manual, Rio Rancho Astronomical Society; No. 68, Mark Bailey, Advanced, Member-at-Large

Radio Astronomy Observing Program
No. 7-G, Alex Vrenios, Lifetime Member; No. 17-S, Aaron Clevenson, North Houston Astronomy Club

Sketching Observing Award
No. 12, Roy Troxel, Member-at-Large; No. 13, Ann Bruun, Astronomy Club of Tulsa; No. 14, W. Maynard Pittendreigh, Lifetime Member; No. 15, Mark Bailey, Member-at-Large; No. 16, Rodney R. Rynearson, St. Louis Astronomical Society

TITLE PHOTOGRAPH: M64, THE BLACK EYE GALAXY; NASA AND THE HUBBLE HERITAGE TEAM (AURA/STSCI)

Southern Skies Binocular Observing Program
No. 97, Lee Sikstrom, Member-at-Large

Southern Sky Telescopic Observing Program
No. 53, Lee Sikstrom, Member-at-Large

Stellar Evolution Observing Program
No. 36, Kristina Otenti, Member-at-Large; No. 37, Stephen A. Tzikas, Northern Virginia Astronomy Club; No. 38, Kevin Carr, Minnesota Astronomical Society; No. 39, Larry Farrington, Mt. Shasta Stargazers; No. 40, Vincent Michael Bournique, Lifetime Member; No. 41, Mike C. Neal, Echo Ridge Astronomical Society; No. 42, Barb Beiver, Rancho Bernardo/Murrieta Astronomical Society; No. 43, George J. Robinson, Member-at-Large; No. 44, Ryan Behrends, Hill Country Astronomers; No. 45, Mark McCarthy, The Astronomy Connection; No. 46, David Whalen, Atlanta Astronomy Club

Sunspotters Observing Program
No. 187, David Novotny, Rose City Astronomers; No. 188, Seth Watts, Member-at-Large; No. 189, John Dorio, Texas Astronomical Society of Dallas; No. 190, Paul Harrington, Member-at-Large

Urban Observing Program
No. 178, Chuck Stewart, Rose City Astronomers; No. 179, Alex McConahay, Pomona Valley Amateur Astronomers

Variable Star Observing Program
No. 26, James Sykes, Olympic Astronomical Society

Coming Events

To have your star party or event listed, please send the details, including dates, sponsors and website, to *astrowagon@verizon.net*. Confirm dates and locations with event organizers. —John Wagoner

March 3–4
Tri-Star 2017
Guilford Technical Community College
Greensboro Astronomy Club and the Cline Observatory
Jamestown, North Carolina
observatory.gtcc.edu/tristar

March 16–19
Don Surles Mirror Making Workshop #17
Redden State Forest, Delaware
delmarvastargazers.org/wp-content/static/mirrormaking

March 22–26
Staunton River Star Party
South Boston, Virginia
www.chaosastro.com/starparty

March 24–26
Pickett Astronomy Weekend
Pickett-Pogue Dark Sky Park
Jamestown, Tennessee
tnstateparks.com/events/details/#/?event=dark-sky-celebration-stargazing-weekend-2017

March 25
2017 All-Arizona Messier Marathon
Salome Emergency Airfield (south of I-10 at Exit 53)
Tucson, Arizona
www.saguaroastro.org/content/messier2017

April 6–7
Northeast Astro-Imaging Conference
Rockland Astronomy Club, Suffern, New York
www.rocklandastronomy.com/neaic.html

April 8–9
Northeast Astronomy Forum and Solar Star Party
Rockland Astronomy Club, Suffern, New York
www.rocklandastronomy.com/neaf.html

April 20–23
South Jersey Astronomy Club Spring Star Party
Belleplain, New Jersey
sjac.us/starparty.html

April 21–22
North Carolina Statewide Star Party
40+ public sky-watching sessions from the mountains to the coast
www.ncsciencefestival.org/special-opportunities/starparty

April 21–23
NCRAL 2017 Convention
Eagle Bluff Environmental Learning Center
Lanesboro, Minnesota
rochesterskies.org

April 27–30
Southern Star Astronomy Convention
Charlotte Amateur Astronomers Club
Little Switzerland, North Carolina
www.charlotteastronomers.org/southernstar

April 29
Astronomy Day
Nationwide
www.astroleague.org/astronomyday/spring

May 6–7
AstroCATS
London, Ontario, Canada
www.astrocats.ca

May 18–21
2017 Bootleg Astronomy Star Party
Green River Conservation Area, Harmon, Illinois
www.bootlegastronomy.com

May 19–21
Michiana Star Party 9
Dr. T.K. Lawless State Park, Vandalia, Michigan
www.michiana-astro.org

May 21–28
Texas Star Party
Fort Davis, Texas
www.texasstarparty.org

May 25–29
RTMC Astronomy Expo
YMCA Camp Oakes, Big Bear City, California
www.rtmcastronomyexpo.org

May 26–28
Tennessee Spring Star Party
Fall Creek Falls State Park, Tennessee
www.cumberlandastronomicalsociety.org

June 2–4
The Symposium on Telescope Science
Ontario Airport Hotel, Ontario, California
www.socastrosci.org/symposium.html

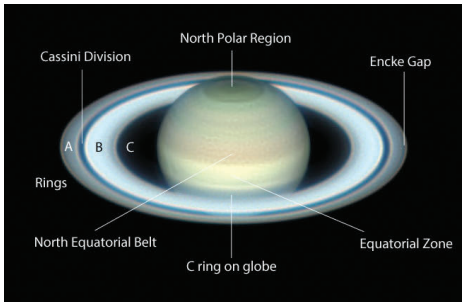
June 9–11
MSRAL 2017 Convention
Missouri State University, Springfield
www.msral.org

June 17–24
Grand Canyon Star Party: North Rim, Arizona
saguaroastro.org/content/2016GrandCanyonStarPartyNorthRim.htm

June 21–25
Rocky Mountain Star Stare 2017
Gardner, Colorado
www.rmss.org

The Rings of Saturn/from page 11

will make a series of daredevil passes between the rings and the planet to gather even more data. Finally, Cassini will burn up in Saturn's atmosphere on September 15, 2017, bringing the curtain down on an unprecedented era of discovery around the ringed planet.



Modern imaging systems and computer processing have allowed amateur astronomers to make stunning images of the planets. This image of Saturn was taken on May 28, 2016, by Michael A. Phillips of Swift Creek, North Carolina, with a 14-inch f/4.5 Newtonian. North is up and east to the left.
Michael A. Phillips, maphilli14.webs.com.

June 22–25
Wisconsin Observers' Weekend
Hartman Creek State Park, just west of Waupaca, Wisconsin
www.new-star.org

July 19–22
Green Bank Star Quest 14
Green Bank Observatory, West Virginia
www.greenbankstarquest.org

August 16–19
AstroCon2017 and Total Solar Eclipse
Casper, Wyoming
www.astroleague.org

ADVERTISING RATES for the *REFLECTOR*

The following is a listing of the advertising rates for the *Reflector*. If you are interested in promoting your products, consider placing an ad with us. We offer a highly targeted market with a circulation of 16,000 astronomers.

Rates for the inside front cover, inside back cover, and back cover are negotiable.

Deadlines: March issue – January 1 June issue – April 1 September issue – July 1 December issue – October 1

Number of Issues	Full Page	1/2 Page	1/3 Page	1/6 Page	Mini Ad
H = Horizontal V = Vertical	7½" H x 10" V	7½" H x 5" V	5" H x 4½ " V or 2⅜" H x 10" V	2⅜" H x 5" V or 4½" H x 2⅜" V	2⅜" H x 2⅜" V
1	$1,000 B/W $1,100 Color	$500 B/W $550 Color	$400 B/W $440 Color	$200 B/W $220 Color	$150 B/W $165 Color
2	$900 B/W (each) $990 Color (each)	$450 B/W (each) $495 Color (each)	$350 B/W (each) $385 Color (each)	$175 B/W (each) $192.50 Color (each)	$125 B/W (each) $137.50 Color (each)
4	$800 B/W (each) $880 Color (each)	$400 B/W (each) $440 Color (each)	$300 B/W (each) $330 Color (each)	$150 B/W (each) $165 Color (each)	$100 B/W (each) $110 Color (each)

Note: Advertising pricing is subject to change without notice.

To submit advertisements or for further information, please contact: Carla Johns, Advertising Representative, at c.johns@icloud.com or 1-970-567-8878.

TITLE PHOTOGRAPH: "CONE NEBULA"; CREDIT: NASA, H. FORD (JHU), G. ILLINGWORTH (UCSC/LO), M. CLAMPIN (STSCI), THE ACS SCIENCE TEAM, AND ESA.

League Sales are online!

The League's online store is available at the website, **www.astroleague.org**. Click on the link for the store on the top right of the home page. The online store includes the latest shopping cart technology and accepts credit cards. Shipping & handling (S&H) is calculated at checkout. Merchandise is also available by mail order, payable by check. Please select your items, add the applicable S&H fee, and mail your order to:

Astronomical League Sales
9201 Ward Parkway, Suite 100
Kansas City, MO 64114

If you have questions about the merchandise, or discounts on bulk orders, please call the League office, 816-DEEP-SKY, or email: **leaguesales@astroleague.org**.

Trucker Hat
Printed logo, adjustable, navy only;
$12, plus $5 S&H

VC600 Baseball Hat
Embroidered logo, adjustable;
Colors: royal, maroon, khaki, navy;
$16, plus $5 S&H

2100 Baseball Hat
Embroidered logo, adjustable; "Sandwich" bill; Colors: sage w/stone trim, stone w/navy trim, navy w/stone trim;
$20, plus $5 S&H

2050 Sportsman Bucket Hat
Embroidered logo, one size; khaki only
$22, plus $5 S&H

Astronomical League travel mug
$10: travel mug plus $1.50 S&H

Astronomical League full color cloth patch (three-inch diameter)
$7 plus $1.05 S&H

Astronomical League blue and white cloth patch (three-inch diameter)
$6 plus $1.05 S&H

Astronomical League lapel pin (one-inch diameter)
$8 plus $1.20 S&H

"Guide to the Stars" 16" Planisphere
$21 plus $3.15 S&H

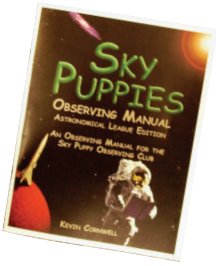
Solar Eclipse Glasses from the Astronomical League!!

10 units:	$ 9.00, plus shipping	250 units:	$ 112.50, plus shipping
25 units:	$ 20.00, plus shipping	500 units:	$ 175.00, plus shipping
50 units:	$ 37.50, plus shipping	1000 units:	$ 300.00, plus shipping
100 units:	$ 60.00, plus shipping		

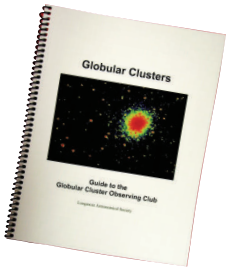
Individual pairs of glasses are also available for $1 each, plus shipping.
Available at http://store.astroleague.org/. Shipping rates will be added at checkout. Or call or email for shipping rates and options.

Get ready for the Great Total Solar Eclipse of 2017! Don't miss out, supplies are limited...

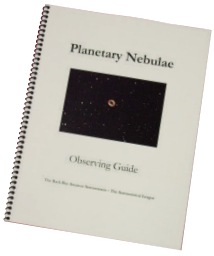
Sky Puppies Observing Manual–
For the Sky Puppy Observers Club
Regularly $15,
Sale price $8
plus $2.25 S&H



Globular Clusters
$14 plus
$2.10 S&H



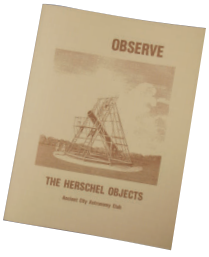
Planetary Nebulae
$14 plus
$2.10 S&H



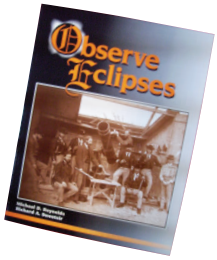
Seasonal Star Chart
$25 plus
$3.75 S&H

Messier Objects: A Beginner's Guide
$8 plus
$1.20 S&H

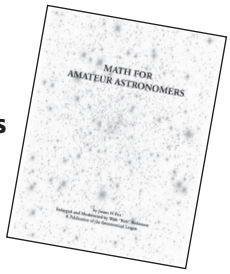
Observe the Herschel Objects
$6 plus
$1.20 S&H



Observe Eclipses
Regularly $18,
Sale price $9
plus $2.70 S&H



Math for Amateur Astronomers
$10 plus
$1.50 S&H



Universe Sampler
$10 plus
$1.50 S&H

Carbon Stars
A guide to the Carbon Star Observing Club
$10 plus
$1.50 S&H

Membership Secretary
Astronomical League
National Office
9201 Ward Parkway, Suite 100
Kansas City, MO 64114

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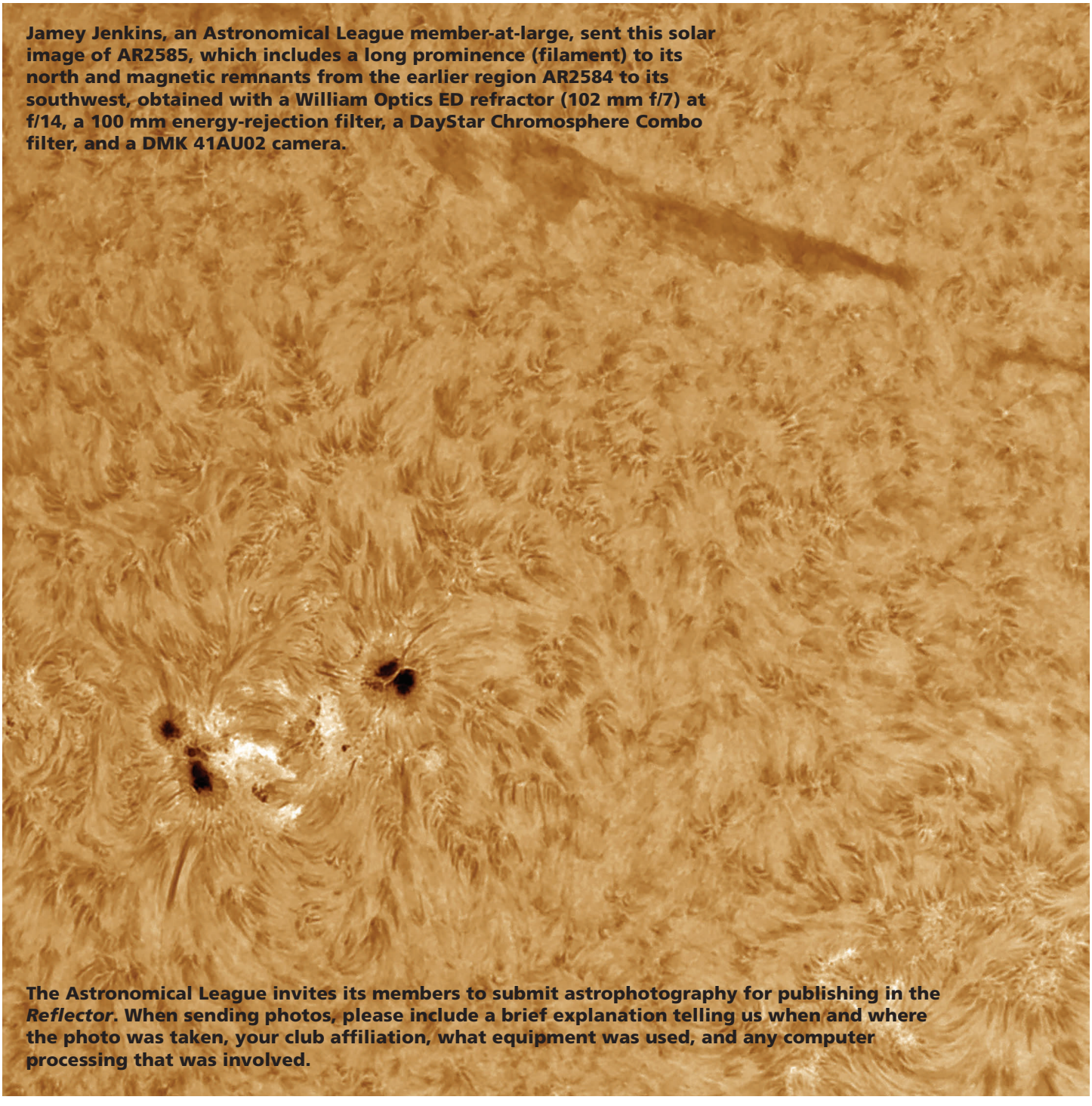

Jamey Jenkins, an Astronomical League member-at-large, sent this solar image of AR2585, which includes a long prominence (filament) to its north and magnetic remnants from the earlier region AR2584 to its southwest, obtained with a William Optics ED refractor (102 mm f/7) at f/14, a 100 mm energy-rejection filter, a DayStar Chromosphere Combo filter, and a DMK 41AU02 camera.

The Astronomical League invites its members to submit astrophotography for publishing in the *Reflector*. When sending photos, please include a brief explanation telling us when and where the photo was taken, your club affiliation, what equipment was used, and any computer processing that was involved.