Reflector

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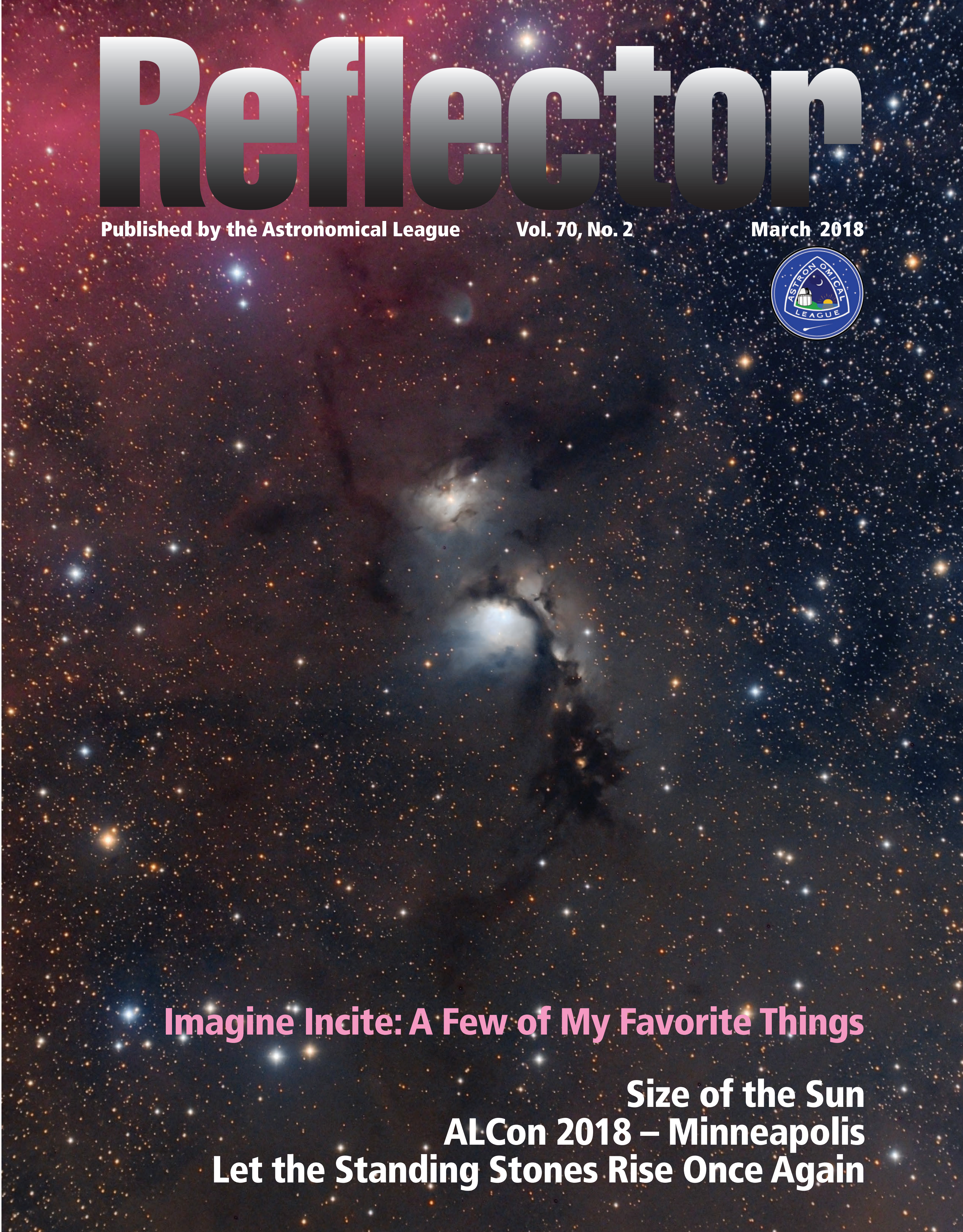

Imagine Incite: A Few of My Favorite Things

Size of the Sun
ALCon 2018 – Minneapolis
Let the Standing Stones Rise Once Again

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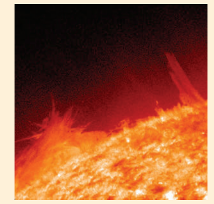

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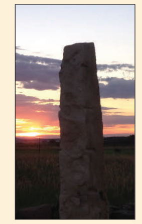

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Bill Neubert (Astronomical Society of Eastern Missouri) took this image of M78 from Buford Mountain Conservation Area using a Stellarvue 80 mm Triplet (reduced to f/4.8—384 mm) with a QSI 683wsg-8 camera.

To our contributors: The copy and photo deadline for the June 2018 issue is April 1. Please send your stories and photos to our managing editor, **Ron Kramer** (*managingeditor@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.

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

Reflector

The Astronomical League Magazine

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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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Field of View

From the office of your president

Why we do what we do

When the cloak of night descends, the enveloping dark acts like blinders focusing our thoughts deep into the starry realm. The enormity of what lies before us engages our minds.

1. We want to feel—not just observe—what the heavens offer. While we direct our gaze skyward, we ponder the implications of "Astronomical Numbers."

• 240,000 miles to our nearest neighbor in space;
• 93,000,000 miles to our parent star;
• 10,000°F on the solar surface;
• over 11 billion miles to the Voyager 1 spacecraft;
• 4.24 light-years to the star closest to our Sun;
• 100,000 light-years across the diameter of the Milky Way, our home galaxy;
• 200 billion stars, give or take, populating the Milky Way;
• 2.5 million light-years to M31, the nearest large spiral galaxy;
• 92 billion light-years across the observable universe;
• 13.8 billion years since it all began.

These numbers represent concepts and values that, whether we realize it or not, we confront every time we peer into the heavens. We may not understand them, we may not feel comfortable with them, and we may not want to accept them, but we know that science has found them to be true. In that regard, we cannot deny them. The awe that is evoked is one reason we do what we do.

2. We want to see the universe for ourselves. We stand poised skyward with our binoculars, telescopes, and cameras. We want to see with our own eyes...

• the shadows at the edge of the lunar night pulling past the triangular radiance of Mons Piton rising in solitude above the plains of Mare Imbrium;
• our Solar System's largest moon, Ganymede, slipping behind the bright disk of giant Jupiter, taking almost nine minutes to disappear from view;
• the lights of M7's nearly 100 distant suns, all twinkling, some at the edge of visibility;
• the gleaming white polar caps on the Red Planet wavering in the eyepiece;
• comets with filamentous tails stretching millions of miles across interplanetary space;
• wispy glowing clouds revealing nascent stars leaving their birth cocoons.

These sights represent a small sample of what the universe offers to those who take the time and make the effort to investigate. They are another reason why we do what we do.

3. We want to understand the universe and our place within it. We frequently engage concepts sometimes too difficult to convey—

• where "giga" is still too small;
• where "nano" is far too large;
• zero;
• infinity;
• eternity.

We simultaneously face the infinite and the infinitesimal. We face immense, almost undefinable, expanses of time, both past and future. All these thoughts and concepts personally affect what we perceive on any clear night.

4. We want to share our celestial encounters with others. We find this to be rewarding in both altruistic and selfish ways. We want to connect with others so they can have a better, more complete understanding of the universe.

The public senses much of this desire, too. How often have you been part of a group gathered to view a feature of the night sky, such as Saturn, when some people appear astounded to hear the distance to that ringed world? When talking about the formation of lunar maria, how many people disbelieve the age of not just our Moon, but of our planet? When looking at its elongated glow through binoculars or a telescope, how many people don't know what to make of the nature of the Andromeda Galaxy? How many people in the crowd truly understand the significance of the incredible numbers we commonly recite during outreach sessions?

R.L. GENT

M31: The vast distance to the Andromeda Galaxy staggers our imaginations. The 2.5 million light-years is a figure always in the back of our minds when we gaze at this wonder. How does it make you feel?

Quite often, the public sees us as an authority on all things astronomical, trusting our every word. In reality, though, we have just as much of an inner sense of awe as they do. We keep our amazement of this universe contained just below our projected confidence as we knowledgeably describe the night sky.

5. We want a personal experience. Standing quietly under the celestial expanse, thinking deep thoughts, one final number frequently comes to mind—a number that we wish was larger, even by just one:

• *1 equals the number of known inhabited worlds.*

That puts us, as amateur astronomers and as members of the Astronomical League, in a very special light, indeed, each time we look skyward. **That is why we do what we do.**

John Goss, League President

Reflector Mail

Dear Editor:

The **Reclaim the Night** bill will be introduced in next session of the Texas legislature, which begins in January 2019. This is a small step on the long road to reduce light pollution by establishing requirements for outdoor lighting to provide a "good neighbor" environment—that is, you can have light, but the light source shall not be visible from an adjacent property.

Almost 400,000 people moved to Texas in 2017 bringing the population to 28.3 million. That is a lot of lighting that degrades our nighttime experience.

The impetus for this effort is the egregious use and abuse of unshielded stadium lighting which lowers the quality of life for anyone within miles of the source, but the proposed legislation does not only concern itself with stadium lighting. There are numerous examples across the state where business owners and individuals cite their property rights to justify their uncaring use of their lighting on their property in total disregard for anyone who might be negatively affected by it. One restaurant in Decatur must close its blinds at night when the car lot next door turns on their security floodlight.

This legislative effort will obviously be opposed by well-funded lobbies whose members will be concerned about the costs involved to add shielding to their existing lighting to insure their lighting only illuminates their property and no other. Yes, there are costs involved, but we are convinced that those costs will be offset by savings associated with using shields, especially with stadium lighting, as said reflective shields allow much cheaper, lower-wattage bulbs to be used, which also lowers the power usage. The bill would provide an adequate time period to come into compliance and penalties for those who choose not to.

Since the only thing legislators understand is money and votes, and since we don't have the deep pockets of a PAC, all we can do is get the grassroots on board. Numbers (votes) are important and building an effective coalition takes time. That is why I am starting as early as I can to get the message out to as many people as I can who would benefit from this legislative effort. Anyone who would be interested in assisting with this project, regardless of party affiliation, is encouraged to contact me at either my Facebook page at *www.facebook.com/profile.php?id=100005185515425*, or by email at *fredstevens@yahoo.com.*

We have an opportunity to make a difference, but it will not be easy.

Please get on board to help Reclaim the Night.

Fred Stevens

Dear Editor:

We, the members (15 of us) of the Stillwater Stargazers of Troy, Ohio, have begun a Library Lending Telescope (LLT) program. We hoped to obtain a scope from the Astronomical League giveaway but were not that lucky. After two tries, the club decided to proceed on its own. In November of 2016 we purchased a lightly used 114 mm StarBlast and prepared it as the New Hampshire Astronomical Society suggested. We offered it to the Troy–Miami County public library. They were reluctant but agreed to start a LLT program since we offered it to them at no cost. After a year of experience with the scope, we found that there was always a waiting list of 10 or more for the 14-day loan.

We decided to see if other surrounding small city libraries might be receptive to a LLT program. We have since placed four scopes in three nearby libraries. We asked them for $300 to cover the cost of the prepared scope.

We chose to use the Meade LightBridge Mini 130 mm tabletop reflector. It offers a little more aperture (130 mm rather than 113 mm) and focal length (650 mm rather than 450 mm) to boost the planet-observing experience. We have found it to be a very good scope. We are currently seeking to add two more local libraries to our program.

Winter is a tough time for newbies to go out and observe, but getting the libraries up and running for the spring thaw is our goal.

Mike Feinstein (chair), Joe DeKold, and Doug Cook
Stillwater Stargazer Outreach Committee
mjfeinstein2@gmail.com

International Dark-Sky Association

Power Companies and Light Pollution

I was recently sent a web article detailing the large amount of light pollution in Belgium—which, from space, appears to be considerably brighter than the rest of Europe. Belgium is the only country in Europe to keep all of its 2.2 million streetlights lit the entire night. One of the reasons for this is the claim that bright streetlights help prevent vehicular accidents on busy roads and provide security. These claims are most hard to prove, and, even so, the rest of Europe and the United States in general do not have such high lighting levels for streetlights and other public lighting applications.

Also, it has been claimed the high lighting levels in Belgium are due to the influence of politicians and lobbyists who own stock or are employed by power companies that profit from high electricity use, the most prominent being Electrabel, the main energy supplier in Belgium. It is beyond my expertise to explore the validity of these claims. However, they raise the frequent assertion that power companies are not interested in combatting light pollution, because they want to sell electricity and increase their profits.

Power companies surely want to sell electricity, but the electricity marketplace is quite complex and dynamic. The electrical grid in North America is vast and covers large regions. Electricity is frequently generated in one state and used in another distant state.

There is a sophisticated market for buying and selling electricity, shifting it around from one place to the next on a moment's notice as needs vary. A region with excess power from a nuclear plant may see some of its power sold at night to a region that receives much of its power from solar panels during the day. This is further complicated by who owns the actual devices using the electricity. In the past it was not uncommon for the local power company to own the streetlights in a community and charge for them based on their usage, clearly a situation that would discourage energy conservation and reduction of light pollution. The opposite scenario occurs when the community or neighborhood owns the streetlights and pays directly for their energy use and upkeep—then, there is a greater incentive to conserve energy, to turn off unnecessary lights, and to tone down light pollution and light trespass.

Nighttime outdoor lighting uses a lot of energy, but it is a small player in total electricity use, perhaps on the order of 5 percent of all electricity production. If all outdoor lighting were turned off, the percent of energy saved would not be large—though the total savings certainly would not be trivial, and the environmental effects of less greenhouse gas emission, less wildlife disturbance, and a dramatic decrease in light pollution could be considerable.

All outdoor nighttime lighting is not going to be turned off, nor should it be. But there should only be lighting that fulfills a genuine function (true safety, security, and recreation). The lighting should be at the lowest levels needed to accomplish its intended use, and it should be designed to minimize light pollution and light trespass.

In some places, there is a struggle to meet electricity demand on hot summer evenings with many air conditioners running. More generating capacity may need to be brought online or more expensive power purchased on the grid. Wasting additional energy on unneeded or poorly designed nighttime lighting is foolish and counterproductive. Energy savings from proper nighttime lighting also helps forestall needed expansion of local or regional power plants. The same logic may be applied to cold winter nights when there is an unusually large power requirement because of the demand for home and business heating with furnaces running full blast.

Often the demand for electricity is greater during the day than at night, making it hard for a local utility to run its generators as efficiently as possible, since it is not easy to turn capacity on and off. In order to run consistently, with more efficient generating capacity at night, a local utility could encourage increased energy use at night, resulting in increased lighting and increased light pollution and light trespass.

My guess is that there are some good and some bad actors selling electricity. My own experience is relatively favorable with regard to electrical utilities and nighttime lighting. The utility representatives I have met and dealt with concerning light pollution and light trespass have been most respectful and helpful. They are members of the same community, and, at least in Arizona, seem to be appreciative of the astronomical community and its needs. They also want to conserve electricity and forestall having to expand their generating capacity for as long as possible.

We all need electricity for modern living and comfort. Just think of the suffering felt recently by those who lost their electrical power for days, weeks, and months due to terrible hurricanes and tropical storms, especially Harvey, Irma, and Maria. Let's be thankful for those who provide our electricity and work around the clock to keep it on. As consumers and protectors of the night sky, let's also keep a wary eye on electricity providers regarding their pricing, their efforts toward energy conservation, and their respect for the night sky.

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All Things Astronomical

January 22, 2018—Penn State Eberly College of Science

Three types of extreme-energy space particles may have unified origin

One of the biggest mysteries in astroparticle physics has been the origins of ultrahigh-energy cosmic rays, very high-energy neutrinos, and high-energy gamma rays. Now, a new theoretical model reveals that they all could be shot out into space after cosmic rays are accelerated by powerful jets from supermassive black holes and they travel inside clusters and groups of galaxies.

The model explains the natural origins of all three types of "cosmic messenger" particles simultaneously and is the first astrophysical model of its kind based on detailed numerical computations. A scientific paper that describes this model, produced by Penn State and University of Maryland scientists, was published as an Advance Online Publication on the website of the journal *Nature Physics* on January 22, 2018.

"Our model shows a way to understand why these three types of cosmic messenger particles have a surprisingly similar amount of power input into the universe, despite the fact that they are observed by space-based and ground-based detectors over ten orders of magnitude in individual particle energy," said Kohta Murase, assistant professor of physics and astronomy and astrophysics at Penn State. "The fact that the measured intensities of very high-energy neutrinos, ultrahigh-energy cosmic rays, and high-energy gamma rays are roughly comparable tempted us to wonder if these extremely energetic particles have some physical connections. The new model suggests that very high-energy neutrinos and high-energy gamma rays are naturally produced via particle collisions as daughter particles of cosmic rays, and thus can inherit the comparable energy budget of their parent particles. It demonstrates that the similar energetics of the three cosmic messengers may not be a mere coincidence."

Ultrahigh-energy cosmic rays are the most energetic particles in the universe—each of them carries an energy that is too high to be produced even by the Large Hadron Collider, the most powerful particle accelerator in the world. Neutrinos are mysterious and ghostly particles that hardly ever interact with matter. Very high-energy neutrinos, with energy more than one million mega-electronvolts, have been detected in the IceCube neutrino observatory in Antarctica. Gamma rays have the highest-known electromagnetic energy—those with energies more than a billion times higher than a photon of visible light have been observed by the Fermi Gamma-Ray Space Telescope and ground-based observatories. "Combining all information on these three types of cosmic messengers is complementary and relevant, and such a multi-messenger approach has become extremely powerful in the recent years," Murase said.

Murase and the first author of this new paper, Ke Fang, a postdoctoral associate at the University of Maryland, attempt to explain the latest multi-messenger data from very high-energy neutrinos, ultrahigh-energy cosmic rays, and high-energy gamma rays, based on a single but realistic astrophysical setup. They found that the multi-messenger data can be explained well by using numerical simulations to analyze the fate of these charged particles.

"In our model, cosmic rays accelerated by powerful jets of active galactic nuclei escape through the radio lobes that are often found at the end of the jets," Fang said. "Then we compute the cosmic-ray propagation and interaction inside galaxy clusters and groups in the presence of their environmental magnetic field. We further simulate the cosmic-ray propagation and interaction in the intergalactic magnetic fields between the source and the Earth. Finally, we integrate the contributions from all sources in the universe."

The leading suspects in the half-century old mystery of the origin of the highest-energy cosmic particles in the universe were in galaxies called "active galactic nuclei," which have a super-radiating core region around the central supermassive black hole. Some active galactic nuclei are accompanied by powerful relativistic jets. High-energy cosmic particles that are generated by the jets or their environments are shot out into space almost as fast as the speed of light.

"Our work demonstrates that the ultrahigh-energy cosmic rays escaping from active galactic nuclei and their environments such as galaxy clusters and groups can explain the ultrahigh-energy cosmic-ray spectrum and composition. It also can account for some of the unexplained phenomena discovered by ground-based experiments," Fang said. "Simultaneously, the very high-energy neutrino spectrum above one hundred million mega-electronvolts can be explained by particle collisions between cosmic rays and the gas in galaxy clusters and groups. Also, the associated gamma-ray emission coming from the galaxy clusters and intergalactic space matches the unexplained part of the diffuse high-energy gamma-ray background that is not associated with one particular type of active galactic nucleus."

"This model paves a way to further attempts to establish a grand-unified model of how all three of these cosmic messengers are physically connected to each other by the same class of astrophysical sources and the common mechanisms of high-energy neutrino and gamma-ray production," Murase said. "However, there also are other possibilities, and several new mysteries need to be explained, including the neutrino data in the ten-million mega-electronvolt range recorded by the IceCube neutrino observatory in Antarctica. Therefore, further investigations based on multi-messenger approaches—combining theory with all three messenger data—are crucial to test our model."

The new model is expected to motivate studies of galaxy clusters and groups, as well as the development of other unified models of high-energy cosmic particles. It is expected to be tested rigorously when observations begin to be made with next-generation neutrino detectors such as IceCube-Gen2 and KM3NeT, and the next-generation gamma-ray telescope, Cherenkov Telescope Array.

"The golden era of multi-messenger particle astrophysics started very recently," Murase said. "Now, all information we can learn from all different types of cosmic messengers is important for revealing new knowledge about the physics of extreme-energy cosmic particles and a deeper understanding about our universe."

The research was partially supported by the National Science Foundation (grant PHY-1620777) and the Alfred P. Sloan Foundation.

KANOKO HORIO

This image illustrates the "multi-messenger" emission from a gigantic reservoir of cosmic rays that are accelerated by powerful jets from a supermassive black hole. The high-energy cosmic rays escaping from the black hole's active galactic nucleus are trapped in the magnetized environment that serves as a reservoir of cosmic rays. The high-energy neutrinos and gamma rays are produced in the magnetized environment during their confinement and in the intergalactic space during their propagation. The ultrahigh-energy cosmic rays, high-energy neutrinos, and gamma rays eventually reach the Earth, where they can give us a unified picture of all three cumulative fluxes of the cosmic particles.

January 9, 2018—Mainz, Germany

Work has begun on the 39-meter primary mirror for the Extremely Large Telescope

Schott has begun manufacturing the Extremely Large Telescope's 39-meter primary mirror, which will be made up of 789 individual pieces and make ELT the largest optical and near-infrared telescope in the world. To make the mirror segments, liquid glass heated to over 1400°C will be poured directly into molds, transferred into a cooling furnace, and subjected to a ceramicization process lasting several weeks. Schott plans to deliver 949 mirrors, which includes replacements, by 2024.

Reflections

As I watched the recent launch of the Falcon Heavy and its Tesla payload, my thoughts drifted back to the 1960s when the U.S. and Russian space programs were on the minds of most people around the world. Culminating in the first manned lunar landing on July 20, 1969, we were very proud of Neil Armstrong and his crew, as well as the NASA engineers and others who made the landing possible.

To be sure, the past five decades have been filled with exciting space news. From the Hubble Space Telescope and other major space observatories to the ISS, an international collaboration, our knowledge of all things astronomical has increased greatly. Spacecraft sent to the other planets have added to this knowledge and will continue to do so.

But this launch was different. For the first time in nearly 50 years, I really feel we are getting serious about human space travel. Our earlier dreams of walking, once again, on the Moon will soon become a reality. Mars landings, while probably ten years (or longer) down the road, will also happen. Humankind will have finally started exploring our Solar System with people, not just robots. Settlements should not be far behind.

Don't get me wrong—robots, landers and orbital machines do a great job and return incredible results. But there is still something unique about an astronaut picking up a Moon or Mars rock, placing it into a sterilized box, and returning it to Earth, where a complete laboratory analysis can provide many more details than a robotic lab can. That is the day I am looking forward to.

I would appreciate any comments on this subject. Please send them to *editor@astroleague.org*.

Now for some down-to-earth subjects. Chuck Beucher, responsible for the design and production of the *Reflector* for the past 14 years, is retiring. Chuck has done an exceptional job of creating exciting issues of our quarterly magazine, and he will be sorely missed.

Of course, we now need a replacement. Further details of the requirements for this position are in the "From Around the League" section of this issue, but briefly, we need someone with experience in the Adobe suite of programs, with emphasis on InDesign, Photoshop, and Acrobat, on either a PC or Mac platform. Prior publishing knowledge would be an advantage, and a résumé is required. Please send this information to *managingeditor@astroleague.org* as soon as possible. Chuck will work through the September issue, and the sooner we can bring somebody on board, the more time can be spent in the transfer of knowledge.

ALCon 2018 is coming. This year's venue is Minneapolis–St. Paul, and the folks up there are planning a great program with speakers, tours, and events. They are taking reservations now and further information is available in the article and advertisement in this issue.

Elections for officers (president, vice president, and treasurer) are drawing near. Look at the information in the "From Around the League" section in this issue.

Finally, please remember that the *Reflector* is your magazine. It features articles and images created by you and other members of the League. We are always looking for new articles and images, as well as new authors and imagers. Send articles to *editor@astroleague.org* and images for consideration for the front cover or "Gallery" section to *photoeditor@astroleague.org.*

Ron Kramer, *Managing Editor*

A MEMBER BENEFIT FROM McDONALD OBSERVATORY

StarDate, the bi-monthly publication of the nonprofit McDonald Observatory, is offering our members a 25% discount. Their magazine provides easy-to-read articles on the latest astronomy research, skywatching, the history of astronomy, and many other topics. *StarDate* also offers starcharts for each month, a sky calendar, and Merlin's answers to reader questions. The discounted rate is $19.50 for members in the continental USA, $22 for Canada, and $30 to other foreign countries. Members-at-Large should send their check (payable to the Astro League) to Astronomical League Office, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114. For member's Societies, the appointed person in each club should gather the subscriptions, and send the appropriate amount to *StarDate* Magazine, c/o Paul Previte, 1 University Station A2100, Austin, TX 78712. You can read more about *StarDate* at *www.stardate.org*. If you have any questions, please contact the League's National Office at *leagueoffice@astroleague.org*

Deep-Sky Objects

Two Globs in Berenice's Hair

By James R. Dire
Kauai Educational Association for Science and Astronomy

The constellation Coma Berenices (Bernice's Hair) dates back to the third century B.C., when Ptolemy III Euergetes ruled Egypt. His wife, Berenice, queen of Cyrene, was proud of her hair and vowed to sacrifice it if Ptolemy III was successful in battle against the Assyrians. Her cut hair disappeared from Aphrodite's temple, where she had placed it. The Greek astronomer Conon of Samos explained that Aphrodite had placed Bernice's hair among the stars, thus the constellation Coma Berenices came into existence.

Coma Berenices is a small northerly constellation lying between Ursa Major, Boötes, and Leo. Located away from the plane of the Milky Way galaxy, this faint constellation has no stars brighter than 4th magnitude and just a handful brighter than 5th magnitude. The constellation is best known for scores of splendid galaxies, including the likes of M64, M85, M88, M91, M98, M99, M100, and NGC 4565.

Coma Berenices contains two globular clusters brighter than magnitude 10. They are known as M53 and NGC 5053. They are two of the easiest deep-space objects to find in the constellation. M53 is found one degree northeast of the star Alpha Comae Berenices, while NGC 5053 is one and a half degrees due east of the star. Normally Alpha is the brightest star in a constellation, with Beta the second brightest. In Coma Berenices, Alpha and Beta are too close in brightness to visually differentiate them. However, photometry has determined that Beta is slightly brighter.

Johann Elert Bode discovered M53 on February 3, 1775. Charles Messier rediscovered it two years later and added it to his catalog. Both Bode and Messier described it as a nebulous object. William Herschel was the first to resolve it into stars.

M53 is one of the most distant globular clusters in our galaxy. It lies 60,000 light-years from the galactic center and 58,000 light-years away from Earth. It has a total luminosity equivalent to 200,000 suns. Visually, M53 has fairly even brightness throughout its 13-arcminute diameter. Its brightest star, a red giant, is magnitude 13.8. The integrated magnitude of the cluster is 7.6, easily within the reach of binoculars. However, an 8-inch or larger telescope is required to resolve it into countless stars.

NGC 5053 is a very loose globular star cluster located one degree southeast of M53. The cluster is magnitude 9.5. The cluster is oval shaped with its longest dimension in the east–west direction, extending 13.7 arcminutes.


M53 and NGC 5053

NGC 5053 is located at approximately the same distance as M53, which means these two globular star clusters are actually near each other in the galactic halo. NGC 5053 does not have a densely packed core like M53, so, for a long time, astronomers did not classify it as a globular cluster. However, spectroscopic studies of the cluster confirmed its true nature. William Herschel discovered NGC 5053 in 1784.

The accompanying image of the two clusters was taken with a 70 mm f/6 apochromatic refractor with a 0.8x focal reducer and field flattener using an SBIG STF-8300C CCD camera. The exposure was 40 minutes. North is up and east is to the left. The image spans three degrees from left to right. The brightest star is Alpha Comae Berenices. Alpha and NGC 5053 nicely form a triangle with M53, which is centered in the image. All three can be spied simultaneously in a rich-field telescope using a low-power, wide-angle eyepiece.

Just north of the trio is a beautiful chain of yellow and orange stars all between 6th and 7th magnitude. The chain is nearly two degrees long, extending from northeast to southwest.

The inset image with the yellow border is a higher-resolution shot of M53 taken with an 8-inch f/6.4 Ritchey–Chrètien telescope using an SBIG ST-2000XCM CCD camera with a 40-minute exposure. In the image, note a great pair of stars just southeast of M53, one red and the other blue-white. These stars are magnitudes 9 and 10, respectively.

While Coma Berenices is famous for its myriad galaxies, when viewing the constellation this spring, don't pass up its splendid colorful stars and globular star clusters!

Wanderers in the Neighborhood

Size of the Sun

By Berton Stevens

Every day, the Sun appears in our sky and, with a proper solar filter to protect the eyes, it appears perfectly round. The edges of the Sun's disk appear sharp and clearly defined. At a distance of 93 million miles, small deviations from its perfection are only barely visible.

The Sun is composed of gas, mostly hydrogen and helium. Its temperature is so high that some or all of the electrons orbiting the atoms are stripped away making them positively charged ions. As ions, they can be influenced by magnetic fields, whereas neutral atoms are insensitive to these fields. When the ions move, as they do constantly, they produce their own magnetic fields. This ionized gas is called plasma.

Near the visible surface, heat from the Sun's core is transferred upward by convection. The hotter plasma deeper in the Sun is less dense than the surrounding cooler plasma. This gives a hotter plasma cell added buoyancy that lifts it upward, though it may be more accurate to say that the cooler plasma surrounding it pushes it toward the surface. There, it bubbles up above the surface, appearing as granulation. The hotter center of the granule is surrounded by cooler plasma that is sinking back into the Sun. These granules can last up to seven minutes before cooling off and dropping back below the surface. This makes the Sun's surface lumpy and not smooth.

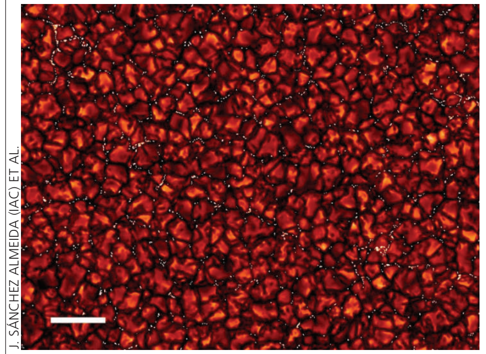
To further complicate matters, if you look at the Sun with a hydrogen-alpha filter, prominences and spicules on the limb are readily visible. While spicules look tiny, these tubes of magnetic force transport solar plasma at up to 60 miles per second and they can be up to six thousand miles long, three-quarters the diameter of the Earth. With thousands of spicules punctuating the limb of the Sun, the Sun's surface is even harder to define.

The Earth's atmosphere begins at the Earth's hard, rocky surface. A gas ball like the Sun does not have a hard surface. However, deep in the Sun, photons cannot travel very far before striking an ion. This prevents us from seeing the inside of the Sun. At the visible surface of the Sun, the density is low enough that photons can move freely and escape the Sun. This defines what we consider to be the surface of the Sun, called the photosphere.

Above the photosphere is the chromosphere, the red layer of mostly hydrogen plasma that appears along the lunar limb during a total solar eclipse, when the bright photosphere is hidden by the Moon. Above the chromosphere is the corona, the beautiful white halo around the totally eclipsed Sun. The corona extends out into the Solar System in the form of the solar wind that induces auroras on many of the planets, including the Earth.

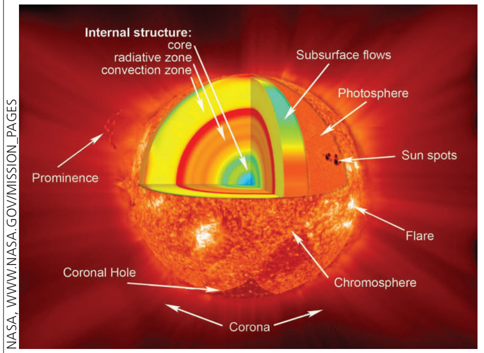
While we think of the Sun as a stable star, we have only known it over a short interval in its long life. Life on the Earth depends on the Sun having a stable energy output. If it starts emitting just a little more energy, the Earth may warm too much for humankind to survive. A similar result would occur if it cooled. We have already had an era when the Earth cooled slightly, from the 16th to the 19th centuries, called the Little Ice Age. The cause of the cooling is still a topic of great debate. However, the Maunder Minimum (1645–1715) occurred in the middle of the Little Ice Age. During the Maunder Minimum, almost no

Continued on page 26



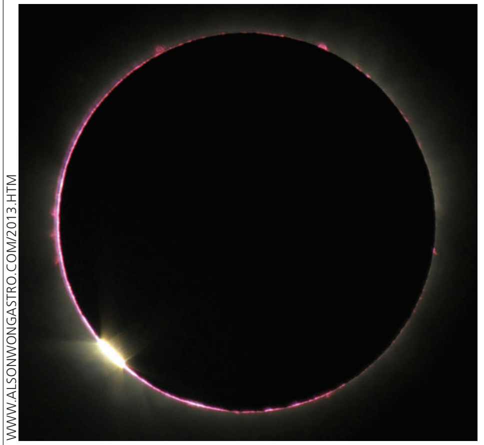
J. SANCHEZ ALMEIDA (IAC) ET AL.

Cells of hotter plasma rise from the interior of the Sun and bubble up on the surface as granulation. The edges of the cell cool and start to sink back into the Sun, forming dark lanes. Inside the dark lanes, small white spots with intense magnetic fields provide a window into the interior of the Sun. Granulation is visible in amateur telescopes during periods of good seeing. For scale, the white bar at the lower left corresponds to 3,107 miles across. This narrowband image was taken in September 2007 using the Swedish Solar Telescope at La Palma, Canary Islands, Spain.



NASA, WWW.NASA.GOV/MISSION_PAGES

A cutaway diagram of the structure of the Sun shows the core where all the nuclear fusion occurs. Energy from the core is transported by radiation upward through the radiative zone. Above that, the energy is transported by convection, with hot plasma bubbling up to the surface. The surface is defined as the point where photons can escape the Sun unhindered, so it is called the photosphere. The chromosphere is the bright red band that can be seen during a solar eclipse. The corona stretches out from the chromosphere into interplanetary space.



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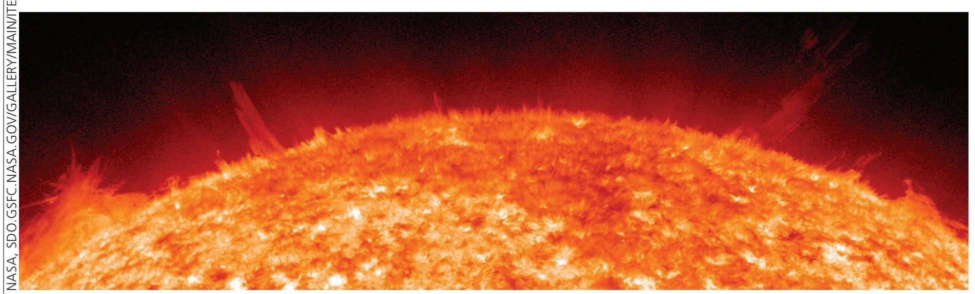
The hybrid eclipse of November 3, 2013, was total near the middle of the eclipse path and annular at the ends where the Moon was farther away and hence smaller. Even near the middle of the path, the Sun and Moon were both almost the same size. The Moon covers all of the photosphere, but leaves the chromosphere visible. This image by Alson Wong taken in Uganda shows the last arc of the photosphere disappearing at second contact while the chromosphere remains visible around the entire eastern limb of the Moon.

BART BILLARD

Baily's Beads taken from near the centerline of the August 21, 2017, total solar eclipse using a PC164C-EX2 video camera with a focal reducer through the Rappahannock Astronomy Club's 5-inch Celestron NexStar telescope and solar filter. It was imaged from Oak Knob in western North Carolina by Barton Billard. Across the bottom of the frame is the timing information encoded by a time inserter, which overlays the information on the analog video signal before it is recorded for later analysis. Courtesy of Barton Billard.



NASA, SDO GSFC NASA.GOV/GALLERY/MAIN/ITEM/27

The surface of the Sun has between sixty and seventy thousand active spicules on its surface at any one time. These tubes of plasma contained by magnetic fields can be as much as 6,000 miles high, with a few reaching ten to twenty times higher than the average spicule. The Sun's north pole is imaged here in the extreme ultraviolet by NASA's Solar Dynamics Observatory.

Let the Standing Stones Rise Once Again

By Russ Erganbright

The goal of the Southern Colorado Astronomical Society, SCAS, is to help each other, members of our community, and anyone interested, gain a better understanding of the universe we live in. What better way could there be than to start with the closest star to the Earth, our very own Sun? While we think of astronomy as a relatively new endeavor going back to the days of Galileo in the 17th century, it is actually much older. In fact, it may be humankind's oldest attempt to understand the world around us! In pursuing the goal of fostering a better understanding of the Universe, the society has begun developing an astronomical park on 35 acres just west of La Veta, Colorado, near the towering Spanish Peaks in the Colorado Rockies.

When completed, the park will have astronomy domes for those with telescopes, away from the lights of cities. It will be a place for those, even without telescopes, to visit and simply enjoy the wonders of the night sky! In the summer of 2015, ground was broken on the first of the astronomical projects planned for the park, perhaps one of the more unusual to be built there: a standing stone circle that functions as a calendar, similar to those built by people for millennia.

But why build a stone calendar thousands of years after the fact? In the coming centuries, if humankind can survive, we may hold within our grasp the ability to set sail from the Earth on the cosmic sea for distant worlds beyond our Solar System. It is just possible that out there, right now, are brilliant young minds just waiting to have their imaginations set ablaze by looking through a telescope for the first time or watching the Sun rise over a standing stone circle on the summer solstice. It is they who hold the knowledge, as yet unrealized, that will permit this ultimate human journey to continue. It's our obligation to future generations to help them along the way. Having a knowledge of where we have been can help provide us with a perspective and prepare us for the future ahead.

When I first explored the feasibility of building a stone solar calendar, I needed to evaluate the organization's property to see if it would be suitable. I arrived well before dawn one cold fall morning to wait for sunrise. While I stood there, shivering in the wind, my mind drifted back to my ancient ancestors from the British Isles who perhaps had stood before a standing stone calendar much like the one I was considering building. Who were these people and how did they live? What mythology did they create around what they were seeing in the sky? Only their stones remain to answer my questions.

As the first rays of sunlight illuminated the site and my shadow stretched out across the field, I knew in an instant that I had come to the right place. In time, standing stones would rise from the earth. Those who would visit here would have the opportunity, in some small way, to touch the distant past. On that morning, I planted a marker where the first standing stone would be placed.

As my enthusiasm for the impending project grew, my mind raced ahead to computer-generated models with animations of the Sun sweeping across the sky on the winter solstice and the placement of stones with laser precision. As a retired engineer, I guess I couldn't help myself—I was lost in the mist of technology, enchanted by the sirens' call of handheld devices, and mesmerized by a seemingly endless number of easy-to-use applications! I rushed to my iPad and downloaded an app to turn my device into a surveyor's transit linked to the GPS network of satellites.

Fortunately, I came to my senses and realized before it was too late that a part of the goal here was, as much as possible, to stick to the old ways in building the standing stone calendar. There would be no blueprints to work from, no computers or other silicon-based life forms of any type used on this project. As the architect, I would see to that, but I'm not going to mislead you to believe that I carried all the stones to the site on my back or braided my hair into a rope to measure distances!

What I can assure you is that all astronomical observations were made with the naked eye and their locations were noted with temporary markers until the permanent standing stones could be installed. Distances were measured with a simple tape measure and roll of twine. Would this calendar be as accurate as it could have been had I used modern technology? No, certainly not, but in its simplicity and flaws lie its authenticity.

I had dressed for the freezing, subarctic conditions of the high country that I knew I would encounter in making winter observations. However, I had made one crucial error in my rush to reach the standing stone calendar site before sunrise to make my observations: I had neglected to bring the proper gloves to operate the camera in the punishing cold. While my heavily insulated mittens would protect my hands, I would now need to remove at least one of them to take photographs. This perhaps wasn't the best of ideas considering the temperature was 8°F with the wind gusting to 25 miles per hour. The snow that had fallen earlier in the month had melted and refrozen, forming tiny solid ice crystals now resembling small shards of broken glass. As the Sun broached the eastern horizon, I braced myself against the wind and slipped my right hand free. In less than a minute, my fingers burned as if I had been stung by wasps; however, the suffering was brief as the pain was swiftly replaced by a dead numbness. In my raw enthusiasm to move forward with the building of the stone calendar project I was running the serious risk of frostbite. Images of mountain climbers with black, rotting fingers came to mind as I struggled to get my mitten back on. I had succeeded at capturing the moment in time with my camera and marked the rising Sun's location on the calendar with a grapefruit-sized stone, but what price would I pay for my stupidity?

As I battled my way back to the refuge of my waiting SUV, I was caught off balance by a gust of wind on the icy terrain and thrown to the ground unceremoniously like a bag of potatoes tossed onto the bed of a flatbed truck. I must have been an amusing sight, rolling around like an overstuffed slug in my bulky garb. Strangely, even under the circumstances, I still found humor in the situation. As I reached the vehicle I had to chuckle to myself; I could see the headlines now: "Local researcher found frozen 50 feet from running vehicle. Coroner rules death accidental due to abnormally high amount of poor planning."

When the time arrived to begin the construction phase, the SCAS was fortunate to receive a generous donation of all the large standing stones required to build the calendar. They had started their lives of service as Kansas fenceposts, carved from limestone formations by skilled masons a hundred or more years ago. They were collected near Dodge City, Kansas, by the gentlemen making the donation, loaded onto trailers, and transported to the site. The remaining stones were donated locally and trucked in by club members. While strenuous and dangerous at times, considering that much of the labor was done by hand, the construction process of the calendar was straightforward. The center standing stone was the first to be erected.

Surrounding the center stone is a circle of smaller river rocks. This formed the observation gallery where the solstices and equinoxes can be seen. Beyond the inner stone circle, along the alignments of the rising and setting Sun on the solstices and equinoxes, are six standing stones each weighing in the range of 350 to 400 pounds. In addition, true north and south are marked on the circle. Enclosed by the circle itself is a star chart carved in stone depicting the location of the North Star, Polaris. The completed calendar is approximately 72 feet in diameter.

How long will this modern-day recreation of an ancient circle stand passively measuring out the changing seasons? Would it be a single season or a thousand years? Only time holds the answer to that question. But if just one young mind becomes enriched and motivated by what they observe there, it was worth all the effort.

For more information, contact Russ Erganbright with the Southern Colorado Astronomical Society at *erganbright@gmail.com*.

Ripples Through Space and Time

Tell a child of a planet with rings and they imagine its wonder. Show a child a planet with rings and they experience its wonder.

In a pond, drop a pebble and watch the ripples expand ever outward.

The Pond

For a generation, devoted groups of amateur astronomers have been sending ripples through space and time by bringing the wonders of astronomy to those who never experienced such marvels.

The Fort Bend Astronomy Club—FBAC for short—has a history of public outreach that extends back to the 1980s. Every Saturday night (barring scheduled hunts, unscheduled floods, or pesky holidays), FBAC volunteers have opened to the public their 18-inch reflector in the East Dome at the Houston Museum of Natural Science's George Observatory in Texas's Brazos Bend State Park. Additionally, the FBAC team provides indispensable support to the observatory's other two domes, and operates many member-supplied private scopes on the observation deck. After 1,800 events, FBAC has touched over 372,000 folks from all over Texas, America, and the world, exposing this multitude to the Moon, planets, stars, comets, clusters, nebulae, and galaxies. Outreach is in our DNA.

DNA being the driver it is, in the 1980s FBAC members sought even greater outreach impact and formed their Astronomy on Wheels (AOW) program, bringing nighttime observation directly to schools and civic organizations. Initially, the AOW program involved a few members, a few scopes, and a few schools. Now the club hosts 24 to 40 AOW events annually, where, on a single night, anywhere from 50 to 1,500 children and adults can be brought into close contact with the night sky via 8 to 20 scopes, multiple binoculars, and 12 to 30 volunteers. A typical AOW event includes indoor presentations to support night sky observations or to compensate for uncooperative weather. The club even provides during-school guest lectures.

But a great astronomy club maintains a balance between dedicated observation and outreach. And while FBAC's outreach pedigree is solid and current, its observation pedigree, which includes nearly 500 asteroid discovery submissions, had grown a bit stale. So, to revitalize disciplined observation, the club is focusing on more group observation and individual observation programs. To that end, observation clubs, both internal to FBAC and those offered through the Astronomical League, are being championed this year.

To generate member enthusiasm for structured observation, FBAC leaned on its outreach exploits to whet the appetite. A few volunteers knew our outreach lineage would satisfy the Astronomical League's requirements for Outreach Program certificates and pins at the Basic, Stellar, and Master levels, but they didn't know to what extent. They gathered the outreach data from the previous six years, sliced and diced it into individual records, formatted it to League requirements, and coordinated with the Reverend Dr. Maynard Pittendreigh, Mitch Glaze, Tom Lynch, and other League staff to ensure clean, by-the-book submissions. They even solicited Master narratives from our colleagues under the guise of preparing an article relating to our club's annual Super Star Awards, another member-created initiative.

To keep the AL awards a surprise, FBAC announced its Super Star Awards would be given out at our monthly meeting on February 17, 2017. However, at the meeting, a change of plan was sprung—we were giving out AL Outreach Awards instead. When the fog cleared a bit, we awarded 66 basic Astronomical League Outreach Program certificates and pins, 46 Outreach Stellar Level certificates, and 21 Outreach Master Level certificates and pins for a total of 133 awards representing 4,394 contact hours. But there is still a bit more fog to clear and dust to settle, so FBAC members should earn at least two more dozen Outreach Awards before the end of this year.

FBAC's Master Outreach Program awardees as of February 17, 2017. They concurrently received their Basic and Stellar awards. Pictured, top row: Jim Jackson, Leonard Ferguson, Ralph Stevenson, Bill Spizzirri, Tony Wiese, Jeff Lepp, Joel Brewer, Curtis Lewis, Steve Clayworth, Jeff Parr, Joe Dellinger, Brad Thomas; bottom row: Jo Sutter, Tracy Knauss, Jack McKaye, Barb Wiese, Susan Sailing, Becky Brewer. Not shown: David Haviland, Mary Lockwood, Justin McCollum, Paul Noll (awarded post–Feb. 17), Don Sailing (awarded post–Feb. 17), Steven Walker. Photo by Susan Sailing.

FBAC's Stellar Outreach Program awardees as of February 17. They concurrently received their Basic awards. Pictured, top row: Judy McKaye, Paul Noll, Don Morris, Mac Hooton, Don Sailing; bottom row: Steve Goldberg, Rosanne Dillon, Amelia Goldberg, Imelda Balane, Susie Lewis, Yolando Balane. Not shown: Edward Balestrine, Michael Fredette, Chuck Hale, Connie Haviland, Jim Hutchinson, Terzah Horton (awarded post–Feb. 17), Dennis Grigassy, Nathan Jones, Paul Makinen, Keith Montz (awarded post–Feb. 17), Jessie Phillips, Richard Schmidt, Alicia Tristan, Jim Verboon. Photo by Susan Sailing.

The Drop

Outreach is its own reward, and, as a club, we've been humbly contented to roll with that philosophy. However, this club initiative was to promote more disciplined observing in the tradition of amateur astronomy—not to seek commendation, but to thank those who made a difference in our outreach. If this mass FBAC introduction to the League's programs increases disciplined observation in our club—great—success; if it prods other individuals and clubs to reach out to the public in more significant ways—doubly great—an unintended benefit..

So, what can FBAC say about outreach? Plenty!

First, anyone can do it. Our awardees range from youngsters currently in middle school to those who remember that first October day when the Space Age was launched along with Sputnik. We are students, homemakers, managers, scientists, teachers, administrators, engineers, professional astronomers, retired folk, programmers, military personnel, government employees, etc., etc., etc. We are native-born and immigrants; people of all faiths, ethnicities, and races; folks from the entire political spectrum. We are novices with less than six months in the hobby and self-made experts with six decades of observation under our belts. But it is not what we are that makes us reach out to others and share our astronomical passion, but who we are: folks willing to offer our knowledge of astronomy with an eager public—and they are eager.

Second, no scope? No problem. If you don't have a scope, how about binoculars? Or laser pointers, or tablets, or cell phones, or just plain eyes? Be resourceful—one member's first scope was a rifle scope, giving a new meaning to "shooting stars." Ordinary hands can point to flares, satellites, and regions spewing meteors. Folks are needed to schedule and arrange events at schools and organizations, to guide the lines, and to explain the workings of a dome or telescope. This is all outreach and none of it is mundane.

One of our members developed a slide presentation a few years back to fill in some time during scope setup. Now we have four members who have developed nearly a dozen presentations for our AOW events on topics such as the relative sizes of planets and orbits, meteors and meteorites, current and future space exploration missions, and gravity. Opening the doors to folks who don't have scopes or have interfering work or life schedules has increased our number of AOW participants, which brings us to our next outreach truism.

Third, outreach is a group activity. It is always a group activity, even if you are the only one reaching out; you always have someone to whom you are reaching. Observing in your backyard? Invite the neighbors and their kids; invite your friends and relatives. You don't need to reach out through a structured club. Outreach can be spontaneous. Improve your neighborhood; make a difference right where you live.

As with any group activity, the more the merrier. With our AOW program we have swelled the social and astronomical interaction within our membership. We are no longer tied to a single monthly meeting, or Saturday night dome operations, or email lists. Reaching out to the public always involves reaching out to our fellow club members. We learn their strengths, we learn about their scopes, we ask for advice on equipment, targets, repairs, and viewing locations. We can touch and feel and even operate that superb Takahashi, we can try out new lenses without the expense, we can learn traditional star hopping or even push-to and go-to techniques. These outreach events are dynamic—for both our audiences and ourselves. This dynamism evolves into stronger teamwork and friendships.

Fourth, it is just plain fun! All our outreach events, especially AOW events, evolve into star parties. After many of our outreach events, 6 to 18 of us hit the nearest decent restaurant for more socialization. Our AOW program runs primarily during the school year, and after 40 events, we are ready for a summer-long rest. But after a summer's break we are more than eager for the outreach to restart. We miss the fun and we miss the reward.

Fifth, outreach is rewarding; it touches the heart. These rewards take on many forms: touching memories, shared excitement, personal joy, even personal preferences in reaching out to the public. Here are some edited thoughts from our Master Outreach folks captured from their narratives...

"A child came to my scope and asked me to describe it to him. That seemed strange, but I did. It was, obviously, dark but I was finally able to see his face. He had no eyes. I took his hands and guided them over the whole scope so he could 'see' what it looked like. He thanked me and was assisted away. I left my scope, walked away to where there was no one else and cried like a baby."

"If the sky is hopeless we can show the public our adventures chasing asteroids. We show images on the computer that we shot through our dome telescope. The goal is for them to realize illustrious scientists aren't behind every discovery. Real people slog away to make it happen. Most science is like Edison, not Einstein."

"Volunteers enjoy it immensely when we hear people, perhaps at their first view through a telescope, exclaim in amazement. Most every visitor, of any age, has a bit of the astronomer's spirit and curiosity."

"When someone gets their first glimpse of the Moon, or Saturn, or the Orion Nebula, the gratifying reward is a gasp of wonder."

"One thing I have found at AOW outreach events is there's always someone willing to ask the question everyone else is thinking of."

"It's like a "shot of happy." Nothing is more satisfying than to hear a guest exclaim, 'Oh my God, that's beautiful.' Talk about a puffy chest."

FBAC's Basic Outreach Program awardees as of February 17. Pictured, top row: Keith Montz, Brooks Runnels, Roland Fields; bottom row: Terzah Horton, Laura Runnels, Anna Leslie, James Wooten, Ken Lim. Not shown: Christophe Caille, John Cavuoti, Pamela Cook, Stephen Cook, Walter Cooney, Madison Dillon, Paul Erway, Jay Ford, Barbara Hassett, Scott Hassett, Miles Huddle, Pam Huddle, Katelyn Stringer, Charlie Throop, Anne Trujillo. Photo by Susan Sailing.

"The first AOW I attended I was a tag along to my brother who was already participating in AOWs. But one time was all it took and I got hooked on this (AOW) outreach program."

"When I attended my first AOW event, I was reluctant to do so since I did not own a telescope. My only asset was a green laser and I learned a green laser is a useful tool. If you don't own a scope just use your laser and help."

"Daddy, Daddy—I saw Saturn—I saw Saturn!"

"As a teen, I had no mentors to help. All I did was look at the Moon and roam the skies observing stars. Imagine my excitement when I roamed right on to Saturn. I saw it but half a second, jumped in excitement, bumped the scope, and never found it again until later in life. But I will never forget that half second of excitement. Today, 65 years later, I go on outreach programs and I get no bigger thrill than when a kid sees Saturn through my scope and I see the same reaction I had as a youth."

"Astronomy is such a great hobby. I've enjoyed it all my life. But it really came alive for me when I started sharing it with others."

"I don't need to convince young people to become astronomers, but if a few feel friendlier toward science, and pursue careers in technical fields, my time was well spent."

"Two young ladies came to my scope. The first asked what she could see. I explained Saturn and its moons. She was talkative and asked many questions, but her friend was silent. After viewing the planet for a minute, she moved away and the second girl looked through the scope. Still silent, she turned to the first girl with a look of confusion on her face. The first girl began using American Sign Language to explain what she was looking at. The look of confusion changed to joy as she started to sign back, then another look in the scope and back to signing. This continued until the second girl understood what her eyes had seen. I was so impressed with the care and compassion this girl had for her friend."

A young girl observes the filtered Sun at FBAC's observatory. Outreach occurs one person at a time at any time of day. Photo by Steve Goldberg.

"One of the best parts is when a child really sees the object, gets excited and tells their friends or parents."

"Observing the night sky is a real-world experience that links us to our ancestors. People are as interested in where things are in the night sky as observing through a telescope. Having a laser pointer handy is a must."

"I like to bring my 3-inch refractor to outreach events; you don't need a large scope to enjoy observing."

"I bring binoculars to AOW events. These allow guests to explore the sky fairly independently and allow them to discover and observe on their own."

"The best indication of satisfaction is when folks ask you to return again and again."

"I have learned no topic is too basic, especially for first time observers."

"For public viewing, I like binocular objects since they provide a 'wow' factor for the public. My goal is to not only educate but to enthuse and get people to look up again and again." It's incredible to show someone something they have never seen and truly light them up."

"What I have learned over the years is that you never know what you will be asked. So, over the years, I have gone home and looked up many things so I would know the answer the next time. I really can't tell who's learned more, me or the students."

"The public image of astronomy is that of a solitary activity, one involving long nights stooped over a telescope eyepiece, in the dark, with a set of complicated star charts nearby and only a glittering spray of stars to keep you company. This can be overwhelming to a beginner. Conducting well-planned outreach events is an effective way of transforming these solitary activities into genuine social events—relaxed, fun environments where beginners can overcome their reservations and participate. That's why they're called star parties, after all!"

The Ripples

So how does this all end? Well, the point is it doesn't. It promotes understanding; understanding within our community, within our club, and within ourselves. And as such, it improves our neighborhoods, our schools, our towns, our nations, and our world. Outreach is incredibly satisfying, often beyond measure. The camaraderie, the friendship, the vitality, the thanks, the faces full of wonder—these are why outreach continues to grow within our club.

Therefore, outreach is dynamic, synergistic, and self-sustaining: it is alive. Its effects, whether due to increased knowledge, increased appreciation for the natural world, increased interaction with our fellow humans, or increased insight into our own essence, ripple ever outward. We see the ripples through the child who is inspired and becomes the innovator or explorer of the future. We see it through the teacher who shares new knowledge with his or her students. We see it in ourselves as we continue to reach out and share with our families, colleagues, or the person who lives three streets away.

No member names were used in this article, for we are one club; we share our passion, our friendship, and now our pride. We are who we are. We are FBAC.

—The FBAC Outreach Team

IMAGINE INCITE

Stardrops in poses
By whiskered jets smitten
Bright proper quasars
Dark lenses are splittin
Round layered images
Gravitas rings
These are a few
Of my favorite things

Starlight touches us. Each time I view an object through my telescope I feel a connection with what I've seen. And, literally, there is. Light from astronomical bodies has traveled between 1.29 seconds and 12.9 billion years to enter my eye. A physical interaction produces changes in my eye and brain that allow perception in both a concrete sense, and an abstract, emotional way. The essence of travel is to experience something of historic or cultural value not available without going there. As observers, this process is reversed, and the light comes to us. Most who have journeyed to the Grand Canyon, the Great Wall of China, the Mona Lisa, or Michelangelo's David will agree the experience of physical proximity inspires and produces connections of more lasting significance than were we to just see their pictures.

The French artist Henri Matisse worked in the first half of the twentieth century, and was described by professor of art history and author Jack Flam as both "very accessible and surprisingly complex" for his balanced treatment of form and subject. In his book, *Matisse in the Cone Collection: The Poetics of Vision*, Flam explains that the artist confronted the world before his eyes, what he could visually perceive, with questions of how to extract meaning. Amateur and professional astronomers make similar attempts in viewing groundbreaking objects and images, such as those of the Hubble Deep Fields, geysers on Enceladus, or gravitational arcs surrounding rich clusters of galaxies. Flam derives his title from the way Matisse "reinvented what he saw as part of the process of trying to perceive and record it in a meaningful way the poetics of vision." The "apropoetic" connection between surname and visual receptor was not unappreciated.

I spent over a decade researching and attempting to observe certain types of astronomical objects to establish such a personal connection, including brown dwarfs and gravitational arcs, with many failures along the way. My non-astronomical friends misread this determination as a type of unrequited obsession, not appreciating the thrill and significance of being one of the first to see something with our own eye. Those who have gazed upon some of the most beautiful objects visible to us likely can. Saturn, the Pleiades, the Moon, Ring Nebula, and M51 seen by someone for the first time in a dark sky through a large instrument all have the power to inspire and fill the receptive with awe. Fortune has placed visual aperitifs near us to whet our observational appetites, but most objects of great astronomical importance are not striking at the eyepiece. Their distance and intrinsic natures may offer only visual subtlety, so we are drawn to them not by sight, but invitation to insight. Once seen, the bond is made, and we know them on a deeper level.

Such is the case with quasars. The brightest of these active galactic nuclei at cosmological distances is 13th magnitude 3C 273, which appears as a mere dot of light in modest aperture telescopes. After the Hubble Space Telescope confirmed in the mid-1990s that these celestial beacons were the cores of galaxies, I teased out detail in a few examples. Several of their surrounding galaxies, called "quasar fuzz," were visible in my 25-inch reflector. The jet of 3C 273 is visible in my 32-inch reflector as a 6–8 arcsecond projection to the southwest. Though almost all these cosmic lighthouses appear stellar, with careful study some reveal detail.

SDSS J1004+4112, photo credit: NASA, ESA, K. Sharon (Tel Aviv University), and E. Ofek (Caltech)

Einstein predicted in 1915 that the gravity of massive objects could lens light, and, in 1979, this theory was reconfirmed by the discovery of the first gravitational lens, the twinned quasar Q0957+561 in Ursa Major. Its two images, of magnitudes 16.5 and 16.7, split by an intervening galaxy, lay 6 arcseconds apart. The details can be appreciated in a 16-inch telescope under good conditions, but what is seen are merely two points of light. Knowing the history of this object, with its conception and discovery, is what greatly enhances its view in the eyepiece.

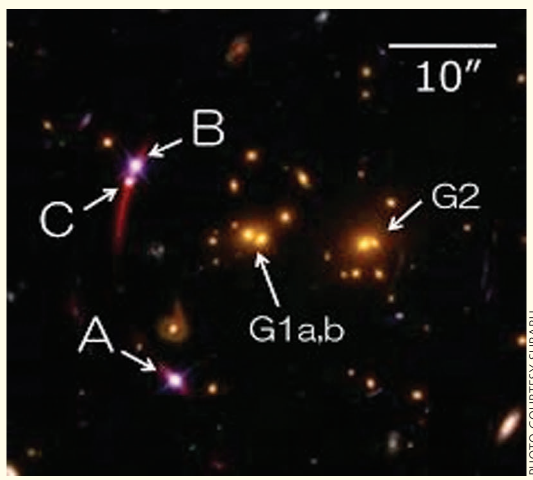


PHOTO COURTESY SUBARU

SDSS J1029+2623

For the next quarter century all seventy or so lensed quasars discovered were contained within the same category: distant objects with their light split by the gravity of a massive galaxy along our line of sight. In fact, the "Twin Quasar" in Ursa Major remained the lens with the widest separation for many years. What changed the field of play, allowing a new type of lensing to be studied, was the Sloan Digital Sky Survey. This 2.5-meter instrument at Apache Point, New Mexico, surveyed one-quarter of the sky from 2000 to 2008. From its multi-wavelength data, in 2003, Inada and his colleagues reported the discovery of a groundbreaking object, SDSS J1004+4112. This was a quadruply lensed quasar in Leo Minor with a remarkable separation of 14.62 arcseconds between its widest components. The great interest it generated in the astronomical community stemmed from its lensing being accomplished not by a single galaxy, which had been the case for all the previous lenses, but by the gravity of a whole galaxy cluster. For the first time this allowed detailed study of mass distribution within the cluster, including its dark matter component. The patterns found were compatible with prevailing cold dark matter theories, and the authors suggested follow-up temporal studies searching for microlensing among the components, and dedicated searches for lensed arcs surrounding the galaxy cluster to further constrain the models. They also predicted similar lenses were lurking within the SDSS data.

Searching for new objects and types of objects to observe within the popular and professional journals, I came across SDSS J1004+4112 in 2004 and placed it on my list to view from a dark site. Though possible to observe from my home, I felt it better to try for this 19th-magnitude object from the dry mountain skies of west Texas. During the 2005 Texas Star Party, using my 25-inch f/5 reflector at 454x, I was able to spot the A and C components. With my 32-inch f/4 the original four lensed quasar images would likely be visible, including the faintest, D, at magnitude 20.4.

Interest in this system sparked further imaging using Hubble and other large instruments, and a cascade of discovery followed their detailed inspection and subsequent research. In 2005 Inada and his group from the University of Tokyo reported a fifth lensed component sitting just west of center of the central cD elliptical galaxy in SDSS J1004, barely discernible even with the fine resolution of the HST. This finding correlated to the slight offset of the other four lenses reported in the discovery paper. NICMOS imaging by HST enhanced the circumferential infrared arcs extending from the original lensed images, and close examination of the deep ACS exposures showed myriad faint, short arclets encircling the cluster, testament to the tremendous gravity subverting the architectural integrity of the original radiation, and enlightening us about cold, dark matters. Careful inspection of Hubble's composite image revealed a jet extending several arcseconds to the east-northeast from the center of the large elliptical galaxy at the cluster's core.

Layers of galaxies appear at various distances, including those nearer to us than the cluster and those behind it. Some spirals within the cluster show disruption from "ram stripping" as they plow through the dense intracluster medium. Forced to form numerous large star clusters, they are aging prematurely. The "strong" lensing of the obviously stretched images of background galaxies strewn around the cluster is accompanied by the visually unobvious "weak" gravitational lensing. This latter type of alteration changes the shape of background galaxies in subtle but predictable ways, allowing detailed mapping of the cluster's gravitational field and, by inference, its dark matter. Understanding the overall structure of the "cosmic web" can be enhanced through studying the symbiosis between galaxy clusters and dark matter. Surveying all this contained in one nutshell, we may be kings of infinite space.

For three years this lens held the separation record, but, in a 2006 *Astrophysical Journal Letters* article, Inada reported on the discovery of what is still the widest separated lens, SDSS J1029+2623. With a 22.3-arcsecond gap between its components, its 18.4- and 19.0-magnitude images are easily seen on the POSS 2 plate. In May 2015, Jimi Lowrey and I viewed this object in his 48-inch reflector in moderate conditions. Initially, at 697x we saw only the A and B lensed components of the quasar, but, using a 6 mm Zeiss Abbe Ortho eyepiece at 813x, we were able to see the two lensing galaxies, G1 and G2, as a combined glow. A third wide cluster lens from Sloan was discovered and reported by Dahle and his colleagues in a 2013 *Astrophysical Journal* paper: SDSS J2222+2745, with a 15.1-arcsecond separation. The POSS 2 red plate, which I use to gauge visibility in my instruments, clearly shows the three quasar components and two central galaxies of the lensing cluster, and hints at the gravitationally lensed arc with a redshift of 2.30. I have tried twice with my 32-inch scope from the Okie-Tex Star Party to split this, but both times

PHOTO COURTESY ROB GENDLER

Q0957+561

the seeing did not allow it to happen. All six components were seen only as one object. What a thrill it would be to observe both a lensed quasar and galaxy arc within the same cluster! Observing such things within images both beautiful and important allow these apices of discovery to offer poetry and meaning to our vision.

Dave Tosteson
djtost1@gmail.com

CHASING 61 CYGNI

A cropped photo of 61 Cygni taken using my 120 mm f/7.5 refractor (exposure time 20 seconds at ISO 800). Immediately adjacent to the upper star (61 Cygni A) is the 10.7-magnitude star TYC-3168-590-1, which is a convenient point of reference for measuring the motion of 61 Cygni.

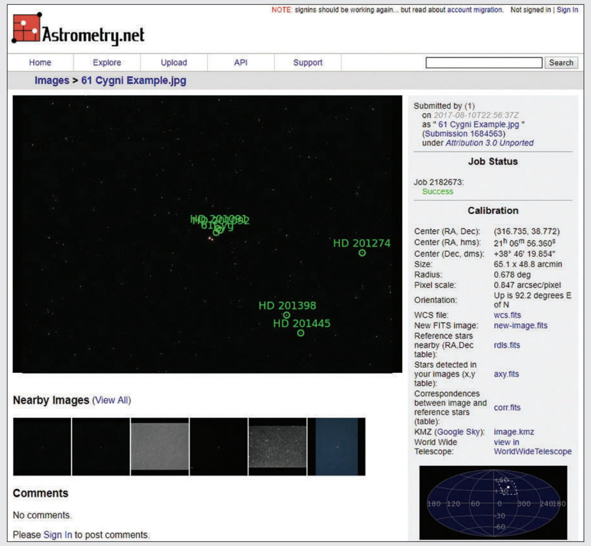
By Steve Smith,
Castle Pines, Colorado
ssmith9831@aol.com

Since the first telescopic observations of 61 Cygni made by James Bradley in 1753, it has been an object of interest to both professional and amateur astronomers alike. On the edge of naked-eye visibility at magnitude 4.8, it was Bradley who first noted that it was, in fact, a binary pair with component magnitudes of 5.21 and 6.03, and this binary status was its primary attraction to early astronomers such as William Herschel. In 1804, Giuseppe Piazzi (who discovered the asteroid Ceres in 1801), while comparing his observations to those made by Bradley some 40 years earlier, detected and quantified the incredible motion of this pair of stars across the night sky at 5.4 arcseconds per year. It was the largest stellar motion recorded at the time, and 61 Cygni soon become known as "Piazzi's Flying Star."

Astronomers were quick to realize that this large motion was most likely an indication of its proximity to our Solar System, and, in 1838, Friedrich Wilhelm Bessel was able to accurately measure its parallax and estimate its distance at 10.3 light-years from Earth—which is not too far from the currently accepted value of 11.4 light-years. This was the first distance measurement for any stellar object other than the Sun, and, at 11.4 light-years, makes it the 17th closest star to our Solar System. The stars that comprise 61 Cygni (A and B) are both orange K-class main sequence stars of 0.73 and 0.63 solar masses and 0.15 and 0.085 solar luminosities, respectively, and orbit each other over a period of approximately 678 years.

Another way to appreciate just how close these two stars are to us is to realize that the separation of the two stars is only 126 astronomical units (Earth–Sun distances), or 2.5 times the maximum distance of Pluto from the Sun. Its annual movement of 5.2 arcseconds per year across the sky is about one-sixth the distance that currently separates the pair. Since its discovery 264 years ago, the pair has moved approximately 23 arcminutes across the sky—three-quarters the angular diameter of the full Moon!

Though we now know of other stars with larger proper motions (Barnard's star being the largest at 10.6 arcseconds per year, 6 light-years distant), 61 Cygni still holds the proper-motion record among those stars visible to the naked eye, and ranks seventh among all stars.

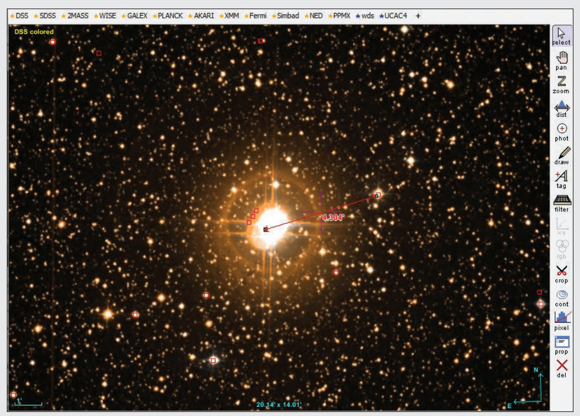


The Astrometry.net *results screen.*

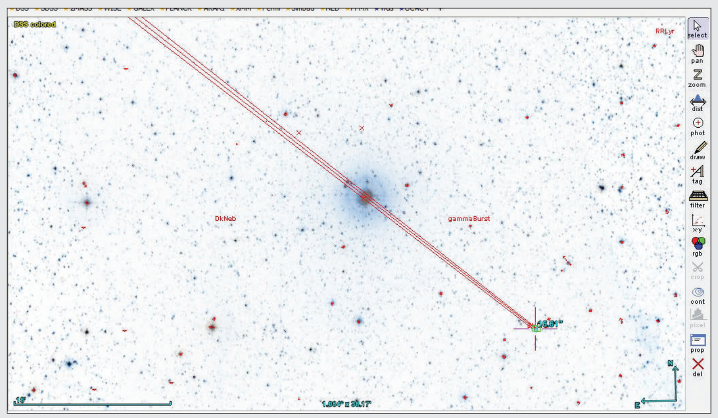
This ruddy orange-red pair stands out against the stellar background and is a beautiful sight in telescopes of any aperture and focal length; its dual nature is evident at even the lowest magnifications. Many double-star enthusiasts feel that the lowest power that enables you to get a clean split provides the most pleasing view.

Although its movement is extremely large in comparison to other stars, over the course of a year or more it is still small by visual standards—but tracking the movement of this pair from year to year is a fun and rewarding exercise. Measurements of this order of magnitude are routinely made by double-star enthusiasts using an illuminated reticle eyepiece, which shows a calibrated ruled scale against the visual magnified image. Due to 61 Cygni's proximity to the 10.7-magnitude star TYC-3168-590-1, it is a simple matter to measure its separation from this star year-to-year using a reticle eyepiece. Its current separation from this star is approximately 25 arcseconds and will be increasing by 5.2 arcseconds per year. Should you wish to locate and record its position more precisely, simply take measurements from one or more additional background stars and triangulate its position on a photocopy of a star chart enlarged to a suitable scale.

Photography is the best way to note and record 61 Cygni's movement over time and has the advantage of preserving a permanent record of its travels. The brightness of the pair makes it a relatively easy photographic subject. Unlike deep-sky astrophotography, which may require exposures from tens of minutes to several hours to capture faint nebulae, stellar photography rarely requires exposures longer than 15 or 20 seconds.

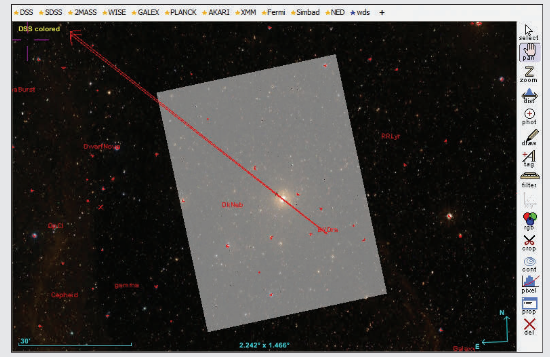


Aladin image window showing 61 Cygni. The SIMBAD database has been loaded and the uppermost star selected. The data for the A component of 61 Cygni is displayed below the image pane.

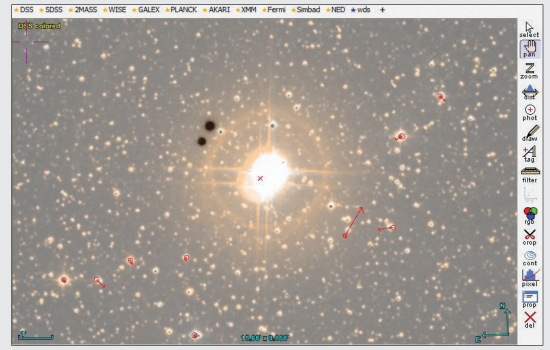


Proper motion vectors displayed in the Aladin Sky Atlas. The image colors have been inverted for better visibility. You can invert the image colors by selecting the DSS layer and then clicking on the "pixel" button on the right-side menu bar. A new window will open with various options; select "reverse."

Possible telescope and camera combinations are too numerous to address in any detail here, but extreme magnification is not required for this project; a tracking equatorial mount is essential. There are numerous websites and YouTube videos available to show you how to set your particular scope and camera up for astrophotography, if this is new to you. Both prime-focus photography (a DSLR-type camera minus its lens attached directly to the back of the telescope) and eyepiece projection (using a fixed-lens or DSLR camera shooting through a low-power eyepiece) are suitable. A 15- to 20-second exposure at ISO 800 in JPEG format is more than adequate, assuming an 80 mm or larger aperture. If your photos show evidence of star trails due to inaccurate polar alignment, just increase the ISO and decrease the exposure time to see if you can reduce the trailing to an acceptable level. If you plan on taking the photos in your camera's RAW format, you will have to convert them to JPEG or FITS format using either your camera's photo processing software or one of the many free conversion utilities available on the web.



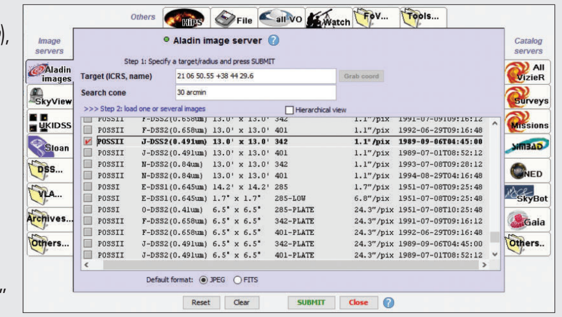
Our plate-solved photo aligned with and superimposed on the Aladin Sky Atlas DSS image.



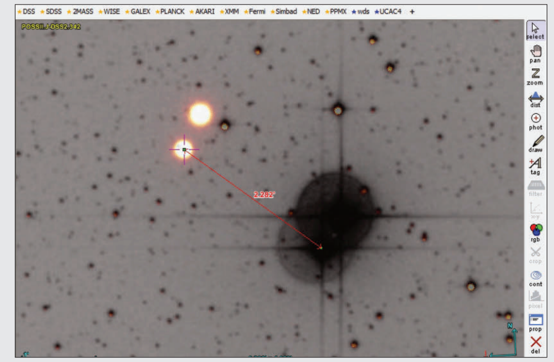
Zooming in on 61 Cygni we can clearly see its remarkable movement against the largely stationary stellar background. Because the image is zoomed in tight on 61 Cygni, its proper motion vectors have disappeared, but the vectors for some of the surrounding stars with smaller motions are still visible.

Once you have your photo—it should show 61 Cygni along with numerous background stars—you can begin the calibration procedure. For calibrating the photo, you can use the free-to-use, web-based astrometric plate-solver at *nova.astrometry.net/upload*. This plate solver will do blind plate-solving, that is, it will determine the celestial coordinates, orientation, and image scale of your photo usually with no additional input required from the user—it is simply magic! You press the upload button, browse to the location of your photo on your computer, and the plate-solving process will begin automatically. I have found that for JPEG images a file size of 500 kilobytes to 1 megabyte works best, no need to upload a 3-meg file. The uploading of the photo and the plate-solving procedure can take several minutes, so be patient. If, for any reason, it cannot find a solution on its own, you are given an option under "advanced settings" to input the approximate coordinates of the center of the photo (in this case, the coordinates of 61 Cygni) to help it begin the solution.

The screen will display "Success" once it finds a solution, and you can click on "Go to the results page," where the plate-solved values for the photo and a copy of your photo showing the major celestial objects it has identified are displayed. If you don't see 61 Cygni displayed, then you may not have photographed the proper location. If you don't have an application that can view and save FITS image files, I suggest you download Fitswork (*www.fitswork.de*), a Windows-based freeware FITS image reader. When you are ready to save the calibrated image, select "new-image.fits" on the *Astrometry.net* results screen, and Fitswork will display the newly created FITS image which you can rename and save to your computer. The point in using FITS format for astronomical image files is that all of the plate-solving data is now stored in the image file, which makes the next part of this project possible.



The Aladin Image Server window, which allows you to load numerous images from the Aladin database. Note the various spectral bands, fields of view, and resolution options available.



Zooming in on the overlay of the J-band image and our photo of 61 Cygni we can observe a clear measurement of its motion. We can use the diffraction spikes to help locate the centers of the stars on the image.

What we are now going to do is compare the current location of 61 Cygni as captured on your photo to its position on an older photo, in this case to Palomar Observatory Sky Survey photos in the Digitized Sky Survey (DSS), which we can access using Aladin Sky Atlas (*aladin.u-strasbg.fr*). Aladin is a professional, web-based, astronomical treasure trove. If you do not already use this this tool you should make a point to become familiar with its capabilities. What we do from here on will illustrate only a small portion of its many features. You will be offered the choice of downloading Aladin Desktop or using the browser-based Aladin Lite; download and install the desktop version.

When you open Aladin, you will be presented with the Aladin workspace, but the viewing area will be blank. Simply type "61 cyg" in the location bar and a DSS photo of 61 Cygni will be displayed. Rotating the thumbwheel on your mouse will allow you to zoom in and out; as you move the cursor around the image, the celestial coordinates will be displayed in the location bar. Take a little time to explore the tools on the right side of the screen, which offer annotation functions similar to many drawing programs. Take particular note of the distance tool which allows you to measure the distance and angle between any two points or objects on the screen.

The image stack is displayed on the right side of the window with the DSS image on the bottom; if you have made any measurements or annotations, a drawing layer will be displayed above it. By right-clicking on a particular layer you can delete or change the display properties of a layer. Checking the box next to a layer will make it the master layer and the other layers become secondary. Each secondary layer will have a small green slider bar below its label to control its transparency, so you can brighten or hide that layer's image or notations.

Now click the "Simbad" button above the image pane, which will load the SIMBAD astronomical database. Each star in the field of view that is part of the database will have a small icon superimposed on the image. If you click on the icon, data for that star will be displayed below the image pane, showing the star's magnitude in various spectral bands, spectral type, proper motion, and so on. You will notice that 61 Cygni has three icons associated with it: one for each individual star of the pair and a central icon that gives the combined magnitude for the pair. If you click the star identifier under "Main ID" in the lower information bar, a new window will open displaying the full SIMBAD data page for that star.

Since we are interested in the proper motions, Aladin can display proper motion vectors for the cataloged stars. Start with a clean screen displaying only the DSS photo of 61 Cygni, and then select the SIMBAD catalog. Once the SIMBAD catalog has loaded, select "Filter" from the right-side menu, which will bring up a new window. Select "Draw proper motions of stars" and click "Apply." Zoom out a bit and you should now see proper motion vectors (arrows) displayed for many of the stars. Each vector points in its star's direction of motion; the length of the vector is proportional to its rate of movement. As you can see, the motion of 61 Cygni far outstrips that of any other star in the field of view.

Another feature is the epoch slider located just below the image stack. With the SIMBAD layer selected, this slider allows you to look at the position of the star forward or backward in time (the epoch). I have set the slider in the image to 1755, near the time of 61 Cygni's discovery, and you can see from this point of origin just how far it has moved in the intervening years.

Now that you are somewhat familiar with a few of the capabilities of Aladin, we are ready to load our photo into Aladin. From the "File" menu choose "Open local file" and select your plate-solved photo. The photo will be loaded as an additional layer and scaled and oriented according to the plate solution. Make sure the DSS layer is on the bottom of the stack and its box is checked making it the master layer. You can then adjust the visibility slider for your photo to obtain an image similar to the one on page 19.

Zooming in on 61 Cygni, the image of 61 Cygni is significantly displaced. You can then position the cursor to obtain its current celestial coordinates as well as use the distance tool to measure its movement.

One problem with using the DSS photos is that the images were taken over a considerable timespan, so it is not possible to precisely associate a time with many of them. However, Aladin has many other images in its database with specific dates.

To retrieve other cataloged images, first click on the location of 61 Cygni to load its coordinates into the image header, and then click on the file folder icon on the left side of the top menu bar which will open the "Aladin Image Server" window. Choose "Aladin Images" from the left-hand menu and a selection of images that cover the target coordinates are listed. I have chosen a J-band (near-infrared) image covering 13 by 13 arcminutes that was taken on September 6, 1989. When you click "Submit," it will be loaded onto the image stack.

Delete or inactivate the DSS image so that only your photo and the new J-band photo are displayed. Using the layer sliders and the pixel menu you can adjust the contrast to suit your needs. Using the "dist" tool we can then measure the distance from the September 1989 image to my September 2016 image, which comes out to 2.282 arcminutes.

If we do the math, 2.282 arcminutes (136.92 arcseconds) in 27 years equals 5.07 arcseconds per year, which is close to the catalog value of 5.23 arcseconds per year.

This little exercise with 61 Cygni shows that by using these readily available tools and simple techniques we can track and measure the movements of high-proper-motion stars. These tools can also be applied to tracking or identifying other celestial objects such Pluto and the outer planets, asteroids, and even comets and can illustrate just how dynamic the seemingly static starry sky really is.

Reference:

"The SIMBAD astronomical database—the CDS reference database for astronomical objects," M. Wenger et al., 2000, *Astronomy & Astrophysics Supplement Series*, v. 143, p. 9–22.

Steve is a proud member of the Denver Astronomical Society.

FROM AROUND THE LEAGUE

Attention Master Observers

The officers of the League would like to again give special recognition to Master Observers who attend ALCon 2018 in Minneapolis–St. Paul, Minnesota.

At the awards banquet on Saturday evening a special wall plaque will be presented in commemoration of your accomplishment. It does not matter what year you became a MO. We only require that you be present at the banquet to receive this recognition.

Over the last three years we have presented Master Observers with special plaques and it will be our pleasure to repeat the honor again as well as at future ALCons. If you will be attending, please contact vice president William Bogardus at *wfbogardus@yahoo.com* before June 11, 2018.

Call for League Officer Nominations

The two-year terms of the offices of president and vice president and the three-year term of the office of treasurer end on August 31, 2018. The current office holders cannot run again for those same offices due to AL term-limit restrictions. If you are interested in using your talents to serve in one of these important positions, we would like to hear from you. Please volunteer!

For specific information regarding the duties and responsibilities of these three offices, please refer to the League's bylaws, which can be accessed on the League website at *astroleague.org*. Each candidate should send a background statement explaining why they are interested, along with a photo of himself or herself, to nominating committee chair Bryan Tobias at *secretary@astroleague.org*. Please limit all statements to approximately 250 words. All nomination materials must be submitted by March 15, 2018, so they can be included in the June *Reflector*, and so election ballots can be assembled.

President Candidate's Statement

William Bogardus

Through the last three years, it has been my pleasure to work with the other officers and league participants as vice president and be a part of the leadership of the League. It has also been a privilege. During that time it has been my delight to make contact with many fellow amateur astronomers and make dozens of new friends. The League is a valuable asset and I would like to be able to continue my involvement as president of the League.

My astronomical interest has been a journey though AL Observing Programs, earning the title of Master Observer (#53). Personal adventures and travels have been to observe eclipses all over the world, trips to the Southern Hemisphere skies, to north of the Arctic Circle to view auroras, to star parties and conventions all over the United States and Canada, and to participate in ALCons since 2006.

Three clubs have contributed to my experience: The RASC Ottawa Chapter, The Amateur Observers' Society of New York, and the Custer Institute. I've held several offices, including president in AOS and Custer. That involvement and leadership included serving as ALCon 2009 chair. I also created the Radio Astronomy and more recently the Celestial Sphere Observing Programs. In 2016, I was honored to be selected for the Astronomy in Chile Educator Ambassadors Program and have continued to be a liaison to that project.

Retiring from a career that included being a secondary school principal, science department chair, and physics teacher, I was first elected League secretary in 2009. In 2013 I was awarded the League's G.R. Wright Award for Outstanding Service to Astronomy. Now, after serving two terms as vice president, I am asking for your support to continue that service as AL president.

Vice President Candidate's Statement

Dr. W. Maynard Pittendreigh

I was seven years old when I made my first, and only, astronomical discovery. With a telescope that barely

qualified as a toy, I spotted a mysterious object. I called for my father and he didn't know what it was either. A few days later we realized we had "discovered" the Orion Nebula. Within weeks I was the proud owner of a 4-inch reflector from Edmund Scientific, which led to an 8-inch reflector a few years later, then a Questar, a NexStar, and a 14-inch Dob. When my wife asked, "How many telescopes does one person need?," I could simply answer, "I'll know when I get there."

The AL has deepened my enjoyment of astronomy. I have particularly enjoyed our observing programs and have earned 48 observing certificates, including Master Observer, Silver Level.

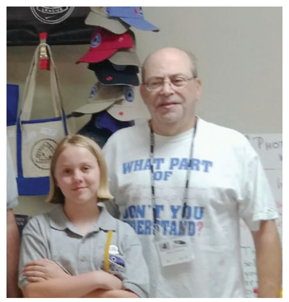
I decided a few years ago that it was time to be give back to the League. I became the coordinator of the Outreach Award Program in 2015. I also coordinate the Sky Puppies and Beyond Polaris programs. I would like to be of greater service to the League and I offer myself as a nominee for office. I have served as an officer in several organizations and offer skills in administration and public speaking. My greatest asset to offer the League is my passion for our organization and our hobby.

Vice-President Candidate's Statement

Ron J. Kramer

The Astronomical League is a thriving business. With members scattered globally, we offer a central location for information, literature, observing programs and awards, outreach, conventions, and a host of other material that benefits amateur astronomers and their associated organizations. We have been doing this for more than 50 years!

Some say astronomy is a dying hobby, that youth have little to no interest, and meaningful discoveries or research can only be done at the university level, or by amateurs with very deep pockets. I disagree.



Ron, with astro-enthusiast Mady France at AstroCon 2017 in Casper, Wyoming.

We frequently read about amateurs who have discovered exoplanets and new nebulae, who work in pro–am cooperative programs and perform significant research. Many of these amateurs are members of your League. New technology in imaging equipment, telescopes, computers, eyepieces, and drive systems offer amateurs capabilities that were unheard of only 25 years ago. Just look at some of the astroimages within the pages of this issue of the *Reflector*.

My experience with the League has been relatively short (eight years). During that time, I have been the *Reflector* assistant editor, editor, and managing editor; executive secretary; and ALCon 2015 host. It is time for me to do more.

As vice president, my goals will be to work very closely with the officers and executive council of the League to develop additional programs for amateurs, address additional funding resources that will allow us to improve all phases of operations, and use my experience of 30-plus years in business management, marketing, operations, and logistics to make the League the primary source of information for amateur astronomers.

FROM AROUND THE LEAGUE

2017 Astronomy Day Report

By Gary Tomlinson, Astronomy Day Coordinator

Every year since 1973, hundreds of locations across the globe celebrate and educate the public about astronomy. The year 2017 marked the 45th such celebration, and as we head towards the 50th Astronomy Day, here is what you can do:

- Start planning for 2018 (April 21 and October 13, 2018).
- Download the *Astronomy Day Handbook* from the League's website (*www.astroleague.org*).
- Enter the 2018 Astronomy Day Award (due June 13, 2018; Fall Astronomy Day events enter the next year's award).

The *Astronomy Day Handbook* was recently updated due in large part to League members Maynard Pittendreigh, Al Lamperti, and Bryan Tobias, as well as *Sky & Telescope*'s senior editor J. Kelly Beatty. The 76-page *Handbook* is chock full of helpful ideas and suggestions for hosting successful Astronomy Day events. If you think your club is too small, think again. One of last year's winning events was organized by one individual who persuaded his friends and students to staff the event, which was held on the sidewalk outside an amusement park.

Budgets for Astronomy Day events range from zero to thousands of dollars. The Kalamazoo Astronomical Society received a grant to fund speakers on the eclipse, like Fred Espenak and Jay Anderson. These wonderful presentations took place within an hour's drive from me; unfortunately, I was out of state at the time. And at a small museum in Connecticut, fifth-grade students staffed Astronomy Day displays on their rainy-day event.

So clubs big and small can hold events utilizing the resources in their own backyard to "Bring Astronomy to the People." The Astronomy Day Award winners for 2017 are:

Best Event by Population Category:

- Dhiren Meshvaniya, India (large)
- Kalamazoo Astronomical Society (medium)
- Travelers Science Dome at the Gengras Planetarium (small)

Best New Idea:

- Travelers Science Dome at the Gengras Planetarium (involving fifth-grade students as student experts)

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 generously agreed to sponsor a new AL award program, the OPT Imaging Awards.

This year the AL will recognize the efforts of imagers with a program where they can submit their best work in four separate categories:

1. Solar System (such as the Moon, Sun, planets, and comets);
2. Deep-sky (such as open clusters, globular clusters, nebulae, and galaxies);
3. Wide-field (such as constellations, the Milky Way, planetary groupings, aurorae, and meteors); and
4. Video or time-lapse imaging showing movement in the heavens.

Each of the four categories will have a first, second, and third place award. Each first place winner will receive a $250 gift certificate from OPT, second place a $125 gift certificate, and third place a $75 gift certificate.

Please see *www.astroleague.org/awards/OPT-Imaging-Awards-Program* for complete details of this wonderful program.

Deadline Approaches for the Mabel Sterns Newsletter Editor Award

The Mabel Sterns Newsletter Editor Award recognizes the work of club newsletter editors across the country. For complete information about the 2018 Mabel Sterns Award program, please see *www.astroleague.org/al/awards/sterns/sternss.html.*

The Astronomical League's Astronomics Sketching Award

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

The Astronomical League offers an award program for sketchers: 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!

Astronomical League Webmaster Award

The Astronomical League's Webmaster Award acknowledges the club webmaster who does an outstanding job of website design and administration.

- The webmaster of any astronomy club that is a current member of the Astronomical League is eligible.
- The website will be judged on its content, ease of navigation, and ability to attract people.
- Club presidents, please send webmaster nominations and the club's website address no later than April 1 to *WebmasterAward@astroleague.org.*

The Astronomical League is giving away up to eleven 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 year a new category is launched, one for members-at-large!

Full details of this wonderful program can be found at *www.astroleague.org/content/library-telescope-program.*

Celestial Savings Program— Your Discount Purchasing Program

The Astronomical League is excited to offer its 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 vary by vendor and by items purchased.

Questions? Write to the Celestial Saving Director at *celestialsavings@astroleague.org*. For more information, see *www.astroleague.org/content/celestial-savings-program—your-discount-purchasing-program.*

Volunteer to be the Chair of the Astronomical League Webmaster Award!

The Astronomical League is seeking a qualified individual who would like to chair the Webmaster Award. Duties for this position include: placing announcements in the *Reflector* and in social media, assembling a team of judges, collecting the nominations, reviewing the eligibility of the nominees, sending the nomination materials to the judges, tallying the results, notifying the winner, writing a brief announcement for the *Reflector* and social media, and ordering and mailing the award plaque.

This is your chance to help the Astronomical League help amateur astronomy by recognizing some of those individuals who make astronomy happen. Interested? Please contact either AL president John Goss, *president@astroleague.org*, or vice president Bill Bogardus, *vicepresident@astroleague.org.*

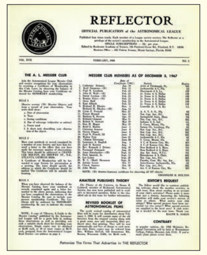
Continued on next page

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

Compiled by Mike Stewart, Astronomical League Historian

February 1968

Fireball Observations Needed



The average amateur astronomer has little concern for the occasional brilliant meteor he may observe during his life. When a meteor as brilliant as Venus streaks through the heavens he may gasp and exhibit a toothy grin because of a predominant feeing of luck. Then, if he possesses the urge to communicate his observation to someone, he derives an omnipotent feeling of pride from making a telephone call to his local police department.

This article is a survey of the things that you, either as a group or as an individual, should endeavor to do when you observe or read a news account of a fireball. You have probably noticed that thus far we have refrained from mentioning the details that should be recorded. First and foremost, the most importance piece of information that you could possibly supply is the elevation and bearing of the meteor at its beginning and end points.

Try your best to approximate these values if you do nothing else.

I'm not sure about the "omnipotent feeling of pride," but standing slack-jawed at the sight of a fireball is a common reaction in my neck of the woods. And calling the local police station doesn't seem like a good idea, either. Nowadays, it's more likely observers would share their experience on social media. Better yet, you can still report fireballs to the American Meteor Society. Every report helps! www.amsmeteors.org/members/imo/report_intro

February 1993

Working with Government Entities—Part I

Working with local governments to control light pollution and light trespass is often time consuming, frustrating, and, at times, nonproductive. Here is some further advice for working with government, entities to enact lighting ordinances.

Two important points to always consider:

1. Organize all your materials and know the facts. Do your homework beforehand. Do not waste people's time.

2. Determine the structure of your local government and the names of key people.

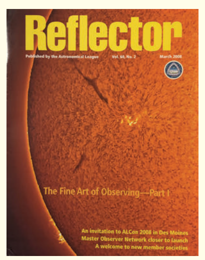
Establish personal contacts with them. It is very important to work with business and community interests to insure cooperation. Do not compromise on the basic principle of establishing a lighting code. All high intensity lighting (street lights, parking lot lighting, security lights, etcetera) should be fully shielded and designed to provide proper illumination without over-lighting. Sports lighting should be designed to minimize light trespass and should be off at a reasonable hour, such as 10:30 PM. You can compromise by grandfathering in all existing lights and by allowing extended time periods for the retrofitting of particularly obnoxious lighting situations.

Emphasize to others that you are interested in lighting that will contribute to public safety, security, and enjoyment but that will not harm the night sky. You do not want to forbid nighttime lighting or put lighting salesmen out of work.

Good advice then, as it is now. The International Dark-Sky Association continues to promote commonsense lighting solutions. www.darksky.org

March 2008

Globe at Night



I hope everyone is participating in Globe at Night. It will take place from February 25–March 8, 2008. It's an easy and fun project to do. Make it a family event and show the kids how light pollution affects our skies. No equipment is needed but your eyes and the charts you can print out from the project's Web site.

In 2006, there were 18,000 people from 96 countries contributing. Approximately 4,600 observations were submitted from all over the world. Observations were submitted from every state in the United States. In 2007, the observations almost doubled. The goal for 2008 is to exceed 10,000 observations. Let's all help them achieve their goal.

Globe at Night is a citizen science project that raises public awareness of light pollution. The organization's website reports: "In 2017 citizen scientists from around the world contributed 15,370 data points! Thank you for helping us achieve our goal of over 15,000 data points!"

In the last ten years, the program has expanded, providing observation opportunities for all twelve months of the year. Participating is quick and easy. www.globeatnight.org

What's new on the League's Facebook page?

How about two downloadable guides to help you enjoy the night sky?

1. "Navigating the Night Sky," a brief, monthly tour of finding your way under the starry dome.

2. "If you can see only one celestial event this month," a description of a fascinating sight that stargazers should not miss.

These materials make great outreach handouts and beginning celestial guides for club newsletters.

Want to join the staff of the *Reflector* magazine?

We have a great opportunity for the right person. Our design and production manager, Chuck Beucher, has decided to resign after 14 years of designing, and producing our quarterly magazine. September will be his last issue and we need a qualified person to take his place. Experience with Adobe InDesign or PageMaker, Illustrator, and Photoshop, on Apple or PC, is required. Must be able to work with and produce files for a commerical web offset printer.

We would prefer to bring the candidate on immediately, so he or she can work with Chuck over the next two issues to gain valuable experience. Please contact *managingeditor @astroleague.org* with your résumé. Please submit samples of your prior work, if available.

League Observing Programs and Awards

Comet Observer's Club

In observing the wonders of the universe, there are perhaps no more wondrous and beautiful objects as comets. Since the invention of the telescope hundreds of years ago, astronomers have continually searched for new comets, and in the process, have discovered nebulae, star clusters, galaxies and more. Comets are important members of our solar system, and their study is important to mankind. We hope you enjoy your quest!

This program will require you to observe or image 30 different comets. Each comet logged should have a set of observations to verify movement against the background stars.

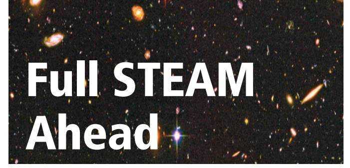
A Silver certificate and lapel pin are given after logging 12 comets. A Gold certificate is given for logging an additional 18 comets.

Messier Program

Almost every amateur astronomer begins to be aware of the Messier Catalog as soon as he or she opens their first book. The novice is sure to find some spectacular object pictured and designated by its "Messier number" with the universal abbreviation "M." Of the myriads of star clusters and nebulae scattered over the sky only about 100 (perhaps 110 at most) can claim membership to this celebrated list. However, this happens to include most, but not quite all, of the finest of these objects observable from mid-northern latitudes.

There is nothing in the catalog that the owner of so humble an instrument as a three-inch reflector cannot reach under good observing conditions. Many of the objects can be seen with binoculars and some with the naked eye. Thus, the Messier Catalog is a happy hunting ground for any amateur with a taste for deep-sky objects.

The Messier Program has a first-level certificate after observing 70 of the Messier objects. An Honorary certificate and lapel pin are given when the full catalog has been observed.



Full STEAM Ahead

By Peggy Walker

The Astronomical League is excited to announce its new endeavor to help stop the graying of amateur astronomy: an ALCon Junior. In a nutshell, ALCon Junior will be an astronomy camp that will run in conjunction with the main conference. It will operate using a children's church model, with the middle school and high school students having the option to attend the main conference or participate in their own sessions. By rallying outreach astronomers for this purpose, a dynamic collaboration will be assembled to impact the future of the science of astronomy in the United States. The desired outcomes are 1) to include families in the yearly programming of ALCon, 2) to spark interest in the hobby of astronomy in the next generation, and 3) to encourage the astronomical sciences in higher education and career decisions.

Currently, clubs host star party events for the public, but there is more to it than only an eyepiece experience. This program will blend hands-on activities and resources with observing, which will impact many others in a memorable way. ALCon Junior will expand this hobby to engage not only the left-brain learners, but the right-brain learners through a STE(A)M model that includes art and music. The goal is to feature resources and activities that will focus on the science, technology, engineering, arts, and mathematics of astronomy.

The first step is to gather resources and activities from the amateur astronomy community and science teachers that result in good success and desired outcomes. Resources to be gathered need to be free of copyright infringement or be compliant to the "terms of use." Resources can include, but are not limited to, books, manuals, URLs, websites, and astronomy apps and software. Once assembled, these resources will be put on an educators portal on the AL website. With the large number of outreach astronomy clubs, help will be greatly appreciated to review and classify the submissions into primary (K to 2nd), elementary (3rd to 5th), middle and high school, and special-needs groups, then subcategorized into science, technology, engineering, arts, and math.

The second part is to be more inclusive; with AL having international club memberships, help from those who could translate submitted resources into another language would be fantastic! Inclusion will also extend to accessible resources geared for children with other abilities so teachers and educators who specialize in this area of education, please submit ideas and resources for special-needs, autism spectrum, blind, deaf, and non-ambulatory students.

As responses come in, teams will be developed for each group to generate and manage the pre-planning for the ALCon launch in 2019. Amateur astronomers and educators are welcome to contact me at *BASidewalkastro@yahoo.com*.

Looking forward to working with you as we go full STEAM ahead!

ALCon 2018 is coming! July 14–18, Minneapolis–St. Paul, Minnesota

Greetings from the Twin Cities of Minneapolis and St. Paul! The Minnesota Astronomical Society is proud to announce we are hosting the 2018 Astronomical League Convention (ALCon 2018) from July 11 to 14, 2018.

Convention pin

Our venue for the convention is the Hilton Hotel conveniently located near the Minneapolis–St. Paul Airport and the world-famous Mall of America. In addition, we will also be showcasing our world-class outreach facility, Eagle Lake Observatory, with its two observatories and classroom facilities.

We have started gathering a great lineup of speakers. Notable speakers who have already accepted our invitation include:

Dr. Pamela Gay—Co-host of the "Astronomy Cast" podcast and Director of Technology and Citizen Science for the Astronomical Society of the Pacific

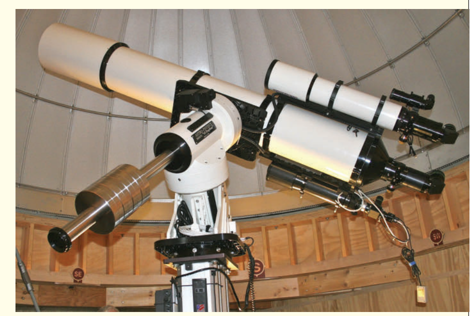
Bob Berman—Astronomer, author, and "Strange Universe" columnist for *Astronomy* magazine

Dr. Phil Plait, a.k.a. the "Bad Astronomer"—Astronomer, writer, and blogger

Bob King, a.k.a. AstroBob—Amateur astronomer, writer, educator, and photographer

In addition, each evening we will have a field trip to Eagle Lake Observatory in Baylor Regional Park to provide viewing through our state-of-the-art telescopes, including our 20-inch Obsession Dobsonian and 8-inch TMB refractor. We'll also have talks in our air-conditioned, bug-free HotSpot classroom. The park will also be the location of our Star-B-Q, with live music on Friday night followed by viewing through our telescopes. Attendees are also welcome to bring their own telescopes and set them up around the observatory.

For a limited number of attendees, we will provide field trips to our Joseph J. Casby Observatory for viewing through our 10-inch TMB refractor, one of the largest refractor telescopes in Minnesota.



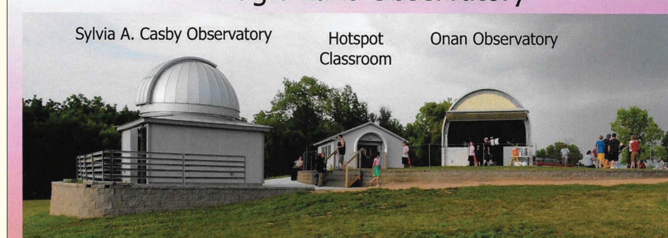
Joseph J. Casby Observatory

We will also have field trips and guided tours to the newly opened Bell Museum of Natural History and Planetarium; the Tate Laboratory of Physics at the University of Minnesota, featuring its 10.5-inch Warner and Swasey telescope built in 1896; and the Science Museum of Minnesota. There will be a wide variety of non-astronomer destinations, including the Mall of America with the indoor amusement park Nickelodeon Universe, the Minnesota Valley National Wildlife Refuge, the Minnesota Zoo, and Paisley Park, the home and studio of the late musician and entertainer, Prince.

So, block your calendar for July 11–14, 2018, and join us for the best ALCon ever! Registration will open in January 2018. Hotel reservations can be made now by calling the Hilton Minneapolis/St. Paul Airport–Mall of America at 952-854-2100. Ask for special ALCon 2018 rates.

Dave Falkner, Valts Triebergs, *ALCon 2018 Co-Chairs*

Eagle Lake Observatory



Wanderers/*from page 10*

sunspots were observed, and when a sunspot did appear, it generated many scientific papers.

A sensitive indicator of the energy output of the Sun is its diameter, since the diameter of a star is related to its energy output—the larger a star's diameter, the more energy it emits. The equatorial diameter of the Sun is 865,278 miles, while its polar diameter is 865,271 miles. This makes it the roundest object in the Solar System, thanks to its tremendous gravity and relatively slow rotational period of 25 to 35 days, depending on latitude. Curiously, the surface of the Sun not only varies due to its rotation, but also due to the local magnetic fields near the surface that can lift or depress it.

Computing the Sun's actual diameter can be done from its angular diameter once the distance to the Sun is known. The first attempt at measuring the Sun's diameter was performed by Greek mathematician Eratosthenes (276–194 BCE), who first measured the circumference of the Earth using geometry. Aristarchus of Samos (310–230 BCE) was able to measure the distance to the Moon by geometry, but the distance to the Sun was harder, and he was unable to get an accurate value.

The first accurate measurement of the distance to the Sun was made in 1771 by French astronomer Jérôme Lalande. It was based on a trigonometric analysis of observations of the transits of Venus that occurred in 1761 and 1769. He calculated a distance to the Sun that was just two percent higher than its known modern value. All these values have been refined over time with sophisticated tools such as radar and spacecraft observations.

The International Occultation Timing Association (IOTA) has found a sensitive way to measure the Sun's diameter by using total solar eclipses. If the diameter of the Sun should change, the times of the beginning and end of totality will change, but those are hard to measure. The northern and southern limits of totality will also change. A bigger Sun will shrink the path width, while a smaller Sun will enlarge it. The path width can be a very sensitive measure of the Sun's diameter that can be made from here on Earth during an eclipse.

At the beginning and end of totality, Baily's beads form as the bright solar photosphere shines through valleys on the lunar edge. Lunar orbiting spacecraft have produced very accurate maps of the heights and depths of the lunar limb that can be used to predict exactly where Bailey's beads will occur. Conversely, observations of Baily's beads can be used to compute the exact location of the totality limit line.

Observations are made from just inside the predicted limit line using a telescope, GPS time inserter, and a video recorder. A GPS time inserter adds the precise time that a video frame is recorded based on the GPS time standard. A display showing the exact time is added at the bottom of the frame. If a time inserter is unavailable, recording a shortwave time signal such as WWV or WWVH will suffice.

IOTA's eclipse edge observations have indicated that the solar radius was 0.4 arcseconds smaller in 1979 than in the total solar eclipse of 1715. A solar eclipse in Rome, Italy, on April 9, 1567, should have been total, but Jesuit astronomer Christopher Clavius reported it as annular, pointing to the possibility that the Sun was even bigger then.

If you would like to join this effort, the United States will see another total solar eclipse crossing the eastern half of the country, from Texas to New England, in 2024. This would be a perfect opportunity to contribute your observations to this important project. For more information on how to make these observations, see the IOTA Eclipse 2017 website (*occultations.org/eclipse2017*) and chapter 11 in the free IOTA Observer's Manual (*www.poyntsource.com/IOTAmanual/Preview.htm*).

Gallery

TITLE PHOTO: NGC 2244; BRIAN KIMBALL

Jeffrey O. Johnson (Astronomical Society of Las Cruces) took this image of IC 5146 (the Cocoon Nebula) from his backyard in Las Cruces, New Mexico, with a Takahashi TOA-130F refractor with a QSI 540wsg CCD camera.

Andrew Klinger (Texas Astronomical Society) took this image of the Horsehead Nebula area in Orion from dark sites in Texas and Oklahoma using a William Optics GT 81 (reduced to f/4.7—382 mm) with a ZWO ASI 1600MM-Cool CMOS camera.

Mike Pusatera (Astronomical Society of Eastern Missouri) took this wide image of bright nebulae in Cygnus from Lake Saint Louis, Missouri, using a William Optics GTF 81 with a QHY9Ms CCD camera.

Brian Ottum (University Lowbrow Astronomers) took this 1.5-day-old Moon shot from Dark Sky New Mexico with a 10-inch f/5 reflector and a Canon 5D Mark III digital camera.

Observing Awards

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.

Active Galactic Nuclei Program
No. 15-I, John Skillicorn, Tucson Amateur Astronomical Association

Advanced Binocular Double Star Observing Program
No. 24, Lisa Wentzel, Twin City Amateur Astronomers; No. 25, Jeff Oaster, Delaware Valley Amateur Astronomers; No. 26, Denise Terpstra, Member-at-Large

Analemma Observing Program
No. 16, Michael A. Hotka, Longmont Astronomical Society

Arp Peculiar Galaxies Northern Observing Program
No. 89-V, Jim Kaminski, Lifetime Member

Arp Peculiar Galaxies Southern Observing Program
No. 13-V, Scott G. Kranz, Astronomical Society of Kansas City; No. 14-V, Jim Ketchum, Astronomical Society of Kansas City; No. 15-V, Kathy Machin, Astronomical Society of Kansas City

Asterism Observing Program
No. 44, Lisa Judd, Denver Astronomical Society; No. 45, Bob Kacvinsky, Prairie Astronomy Club

Asteroid Observing Program
No. 50, Al Lamperti, Regular, Delaware Valley Amateur Astronomers; No. 59, Terry N. Trees, Gold, Amateur Astronomers Association of Pittsburgh; No. 60, George Robert Kepple, Gold, Huachuca Astronomy Club

Beyond Polaris
No. 9, David Whalen, Atlanta Astronomy Club; No. 10, Marie Lott, Atlanta Astronomy Club; No. 11, Ramiro Rodriguez, Raleigh Astronomy Club

Binocular Double Star Observing Program
No. 128, Jonathan Poppele, Minnesota Astronomical Society; No. 129, David Tamburin, Member-at-Large; No. 130, David Leaphart, Member-at-Large; No. 131, Michael C. Stinson, Member-at-Large; No. 132, Dan Otte, Southern Oregon Skywatchers; No. 133, William Steen, Astronomy Club of Tulsa; No. 134, Edgar G. Fischer, The Albuquerque Astronomical Society

Binocular Messier Observing Program
No. 1121, Clifford Bullock, San Bernardino Valley Amateur Astronomers; No. 1122, Michael Robbins, Northern Virginia Astronomy Club; No. 1123, John E. Hill, Minnesota Astronomical Society; No. 1124, Edward Swaim, Central Arkansas Astronomical Society; No. 1125, Vincent Giovannone, Member-at-Large; No. 1126, Alan Snook, Member-at-Large; No. 1127, Joe Timmerman, Minnesota Astronomical Society; No. 1128, Steven Powell, Houston Astronomical Society

Binocular Variable Star Observing Program
No. 20, David Whalen, Atlanta Astronomy Club; No. 21, Jonathan Poppele, Minnesota Astronomical Society; No. 22, Rodney R. Rynearson, St. Louis Astronomical Society; No. 23, Kristine Larsen, Springfield Telescope Makers; No. 24, Marie Lott, Atlanta Astronomy Club; No. 25, Denise Terpstra, Member-at-Large; No. 26, Katarina Holmquist, Member-at-Large

Carbon Star Observing Program
No. 83, Chuck Stewart, Rose City Astronomers; No. 84, Michael D. Stewart, Astronomical Society of Kansas City; No. 85, David Whalen, Atlanta Astronomy Club; No. 86, Marie Lott, Atlanta Astronomy Club; No. 87, Douglas L. Smith, Tucson Amateur Astronomy Association; No. 88, Joe Timmerman, Minnesota Astronomical Society; No. 89, Peter Detterline, Member-at-Large

Comet Observing Program
No. 96, Christian Weis, Silver, Tucson Amateur Astronomy Association; No. 38, Paul Robinson, Gold, Longmont Astronomical Society; No. 97, Paul Harrington, Silver, Member-at-Large

Constellation Hunter Observing Program (Northern Skies)
No. 194, Lynn Ward, Neville Public Museum Astronomical Society; No. 195, David Douglass, East Valley Astronomy Club

Constellation Hunter Observing Program (Southern Skies)
No. 12, Fernando Torres, The Albuquerque Astronomical Society

Dark Nebulae Observing Program
No. 27, Mark McCarthy, The Astronomy Connection

Deep Sky Binocular Observing Program
No. 392, John L. Goar, Olympic Astronomical Society; No. 393, Kim Balliett, Richland Astronomical Society; No. 394, Ron Balliett, Richland Astronomy Society; No. 395, Lisa Wentzel, Twin City Amateur Astronomers

Double Star Observing Program
No. 602, Rene G. Rodriguez, Ventura County Astronomical Society; No. 603, Lisa Wentzel, Twin City Amateur Astronomers; No. 604, Brook Belay, Atlanta Astronomy Club; No. 605, Bill Bond, Omaha Astronomical Society; No. 606, Yu-Hang Kuo, Seattle Astronomical Society

Globular Cluster Observing Program
No. 311-I, Marie Lott, Atlanta Astronomy Club

Herschel 400 Observing Program
No. 584, Benito Loyola, Back Bay Amateur Astronomers; No. 585, William T. Conner, Indiana Astronomical Society

Herschel II Observing Program
No. 103, David Whalen, Device-Aided, Atlanta Astronomy Club

Hydrogen Alpha Solar Observing Program
No. 38, David Bender, Boulder Astronomy and Space Society; No. 39, Craig Lamison, Houston Astronomical Society

Lunar Observing Program
No. 1000, Brook Belay, Atlanta Astronomy Club; No. 1001, Gary Dietz, Astronomy Enthusiasts of Lancaster County; No. 1006, Mark Prouty, Olympic Astronomical Society; No. 1007, Alfred Shovanez, Astronomical Society of Eastern Missouri; No. 1008, Edward Swaim, Central Arkansas Astronomical Society; No. 1009, Jim Dixon, Central Arkansas Astronomical Society; No. 1010, Daniel Lotspeich, Rose City Astronomers; No. 1011, Scott Cadwallader, Baton Rouge Astronomical Society; No. 1012, Rick Olinger, Tucson Amateur Astronomy Association; No. 1013, Len Philpot, Pontchartrain Astronomical Society; No. 1014, William Conner, Indiana Astronomical Society; No. 1015, Nancy Rauschenberg, Minnesota Astronomical Society; No. 1016, Rakhal Kincaid, Haleakala Amateur Astronomers; No. 1017, Christen Slotten, Olympic Astronomical Society; No. 1018, David Tondreau, Denver Astronomical Society; No. 1019, Donald Selle, Houston Astronomical Society; No. 1020, Steve Bardus, Member-at-Large; No. 1021, Steven Powell, Houston Astronomical Society; No. 1022, Andrew Jaffe, New Hampshire Astronomical Society; No. 1023, Michael Shaw, Atlanta Astronomy Club

Master Observer Award (Progression)
Advanced Observer Award
David Whalen, Atlanta Astronomy Club

Master Observer Award—Gold
Al Lamperti, Delaware Valley Amateur Astronomers; W. Maynard Pittendreigh, Brevard Astronomical Society

Messier Observing Program
No. 2771, Jesse Roberts, Regular, North Houston Astronomy Club; No. 2772, Jack Fitzmier, Honorary, Atlanta Astronomy Club; No. 2773, Alan Sheidler, Regular, Popular Astronomy Club; No. 2774, William A. Kast, Honorary, Denver Astronomical Society; No. 2775, Edward Swaim, Regular, Central Arkansas Astronomical Society; No. 2776, Kristopher Setnes, Honorary, Minnesota Astronomical Society

Meteor Observing Program
No. 60, Steve Jaworiwsky, Honorary 63, Howard Astronomical League; No. 124, W. Maynard Pittendreigh, 12 hours, Brevard Astronomical Society; No. 135, Jonathan Poppele, 24 hours, Minnesota Astronomical Society; No. 151, Grace Aikman, 24 hours, Member-at-Large; No. 173, Vincent Michael Bournique, Honorary 64, Lifetime Member; No. 179, Coy Wagoner, Honorary 65, Baton Rouge Astronomical Society; No. 184, Paul Harrington, Honorary 66, Member-at-Large; No. 187, Pamela Lubkans, 18 hours, Member-at-Large; No. 186, Lynn Ward, 6 hours, Neville Public Museum Astronomical Society; No. 188, Valorie Whalen, 6 hours, Atlanta Astronomy Club; No. 189, David Whalen, 6 hours, Atlanta Astronomy Club

NEO Observing Program
No. 13, Marie Lott, Intermediate, Atlanta Astronomical Society; No. 14, Dan Crowson, Intermediate, Astronomical Society of Eastern Missouri

Open Cluster Observing Program
No. 83, Wyatt Sanford, Jackson Astronomical Society; No. 84, John Sikora, Lake County Astronomical Society

Outreach Observing Award
No. 415-M, Mike McCabe, South Shore Astronomical Society; No. 434-M, Kristine Larsen, Springfield Telescope Makers; No. 596-S, Mitchell Milani, Popular Astronomy Club; No. 597-S, Dino Milani, Popular Astronomy Club; No. 801-M, Jim Hutchinson, Fort Bend Astronomy Club; No. 814-S, Laura Runnels, Fort Bend Astronomy Club; No. 828-S, James Wooten, Fort Bend Astronomy Club; No. 839-S, Jim Erwin, Naperville Astronomical Association; No. 842-S, Anna Leslie, Fort Bend Astronomy Club; No. 851-S, Roland Fields, Fort Bend Astronomy Club; No. 856-S, Rodney R. Rynearson, St. Louis Astronomical Society; No. 875-S, Steven White, Colorado Springs Astronomical Society; No. 918-S, Marilyn Perry, Member-at-Large; No. 919-S, Keith Krumm, Seattle Astronomical Society; No. 929-O, Collette Cameron Sarver, Minnesota Astronomical Society; No. 930-O, Mike Mack, Popular Astronomy Club; No. 931-O, Roger Pommerenke, Roanoke Valley Astronomical Society; No. 932-M, Fred Schumacher, Member-at-Large; No. 933-O, Jon Thomas, Indiana Astronomical Society; No. 934-O, Darien A. Bradley, Roanoke Valley Astronomical Society; No. 935-M, Walter Jablonski, New Hampshire Astronomical Society; No. 936-O, Connie Kelher, Huachuca Astronomy Club; No. 937-S, Jim McMillan, Boise Astronomical Society; No. 938-M, Danielle Rappaport, San Antonio Astronomical Association; No. 939-M, Blake Hurlburt, San Antonio Astronomical Association; No. 940-O, David F. Orth, Miami Valley Astronomical Society; No. 941-O, Mark Davidson, Miami Valley Astronomical Society; No. 942-O, Alan Rutter, Flint River Astronomy Club; No. 943-O, William T. Conner, Indiana Astronomical Society; No. 944-O, Bruce E. Bowman, Indiana Astronomical Society; No. 945-O, Jeff Bennett, Fort Bend Astronomy Club; No. 946-O, Dan Pillatzki, Flint River Astronomy Club; No. 947-O, Molly Wakeling, Miami Valley Astronomical Society; No. 1000-M, Sim Picheloup, Fort Bend Astronomy Club

Southern Skies Binocular Observing Program
No. 100, Fernando Torres, The Albuquerque Astronomical Society

Southern Sky Telescopic Observing Program
No. 57, Richard Brown, Texas Astronomical Society of Dallas

Two in the View Observing Program
No. 23, Steve Coltrin, Rio Rancho Astronomy Club; No. 24, Rob Torrey, Houston Astronomical Society; No. 25, Chris Slotten, Olympic Astronomical Society; No. 26, Al Schlafli, Colorado Springs Astronomical Society; No. 27, Ryan Behrends, Hill Country Astronomers; No. 28, Mark Prouty, Olympic Astronomical Society

Universe Sampler Observing Program
No. 131, Daniel Otte, Telescope and Naked-Eye, Southern Oregon Skywatchers

Urban Observing Program
No. 189, Edgar Fischer, The Albuquerque Astronomical Society; No. 190, Robert Togni, Central Arkansas Astronomical Society; No. 191, Kevin McKeown, The Albuquerque Astronomical Society

Variable Star Observing Program
No. 27, Steve Boerner, Member-at-Large; No. 28, Michael A. Hotka, Longmont Astronomical Society; No. 29, Dan Crowson, Astronomical Society of Eastern Missouri

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Ordering is simple enough. Just provide the name of the item, author, publisher (if known), the retail price, and the shipping address. Be sure to include a check or money order—payable to Astronomical League Book Service—for the retail price minus 10%. Shipping and handling are free. Sorry, credit cards are not accepted.

Mail your requests to:
Star 'N Space Books, 324 W. Gurley St., Prescott, AZ 86301.

You should receive your order within two to three weeks.

This benefit is made possible by the efforts of League volunteer Marilyn Unruh, proprietor of Star 'N Space Books. She is also an avid amateur astronomer. Like many of the League's members, she desires to help others enjoy our fascinating avocation. Marilyn notes, "This service allows me to give back to the astronomical community by doing something that I love to do—deal in books!"

For members who are looking to add to their library, the Book Service is definitely the place to go!

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 2–3
Tri-Star 2018
Guilford Technical Community College, Jamestown, North Carolina
Greensboro Astronomy Club and the Cline Observatory
observatory.gtcc.edu/tristar

March 14–18
Staunton River Star Party
South Boston, Virginia
www.chaosastro.com/starparty/index.html

March 16–19
Don Surles Mirror Making Workshop No. 18
Delmarva Star Gazers
CANCELLED

March 17
2018 All-Arizona Messier Marathon
Salome Emergency Airfield (south of I-10 at Exit 53), La Paz County, Arizona
www.saguaroastro.org/content/2018%20Messier%20Marathon/AllArizonaMessierMarathonAnnouncement.html

April 5–8
Southern Star Astronomy Convention
Charlotte Amateur Astronomers Club, Little Switzerland, North Carolina
www.charlotteastronomers.org/southernstar

April 12–15
South Jersey Astronomy Club Spring Star Party
Belleplain, New Jersey
www.sjac.us/starparty.html

April 19–20
Northeast Astro-Imaging Conference
Rockland Astronomy Club, Suffern, New York
www.rocklandastronomy.com/neaic.html

April 20–21
North Carolina Statewide Star Party
40+ public sky-watching sessions from the North Carolina mountains to the coast
www.ncsciencefestival.org/starparty

April 21
Pickett Spring Astronomy Day
Pickett-Pogue Dark Sky Park, Jamestown, Tennessee
www.tnstateparks.com/events/details/#/?event=spring-astronomy-day-2018-4-21

April 21
Astronomy Day
Nationwide
www.astroleague.org/astronomyday/spring

April 21–22
Northeast Astronomy Forum and Solar Star Party
Rockland Astronomy Club, Suffern, New York
www.rocklandastronomy.com/neaf.html

May 4–5
NCRAL 2018
Door County, Wisconsin
www.doorastronomy.org/ncral-2018

May 6–13
Texas Star Party
Fort Davis, Texas
www.texasstarparty.org

May 10–13
Star Gaze XXV
Trap Pond State Park, Laurel, Delaware
www.delmarvastargazers.org/star-party/star-gaze-xxv

May 18–20
Michiana Star Party 10
Dr. T. K. Lawless Park, Vandalia, Michigan
www.michiana-astro.org

May 24–28
RTMC Astronomy Expo
YMCA Camp Oakes, Big Bear City, California
www.rtmcastronomyexpo.org

June 7–10
Bootleg Spring Star Party
Green River Conservation Area, Harmon, Illinois
www.bootlegastronomy.com

June 9–16
Grand Canyon Star Party: North Rim
Fredonia, Arizona
www.nps.gov/grca/planyourvisit/grand-canyon-star-party.htm

June 11–15
Logan Valley Star Party
Malheur National Forest, Oregon
sites.google.com/view/loganvalleystarparty

June 13–17
Rocky Mountain Star Stare 2018
Gardner, Colorado
www.rmss.org

July 11–14
Green Bank Star Quest XV
Green Bank Observatory, West Virginia
www.greenbankstarquest.org

July 11–14
ALCon 2018
Minneapolis–St. Paul, Minnesota
www.astroleague.org/content/alcon-2018

July 12–15
Wisconsin Observers' Weekend
Hartman Creek State Park, just west of Waupaca, Wisconsin
www.new-star.org/index.php?option=com_content&view=category&layout=blog&id=38&Itemid=82

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 2³⁄₈" H x 10" V	2³⁄₈" H x 5" V or 4½" H x 2³⁄₈" V	2³⁄₈" H x 2³⁄₈" 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.

Astronomical League Membership-at-Large Program

What does the League offer you as Members-at-Large?

- Full voting privileges at AL meetings.
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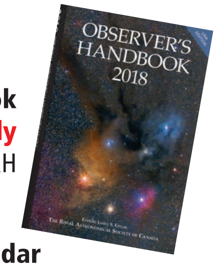
- Free Astronomical League Observing guide with membership.

To join the Astronomical League as a Member-at-Large, send a check for $40.00, $50.00 foreign, made payable to the Astronomical League, to:
Astronomical League National Office, 9201 Ward Parkway, #100, Kansas City, MO 64114
Phone: 816-333-7759; Email: *leagueoffice@astroleague.org*
Or join online at: WWW.ASTROLEAGUE.ORG

League Sales are online!

The League's online store is available at the website, **www.astroleague.org**. Click on the link on the left side 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**.



RASC 2018 Observer's Handbook
Limited Quantities–Order Early
$24 plus $4.50 S&H

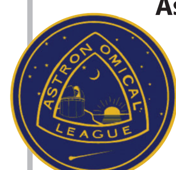
RASC 2018 Calendar
Limited Quantities–Order Early
$18 plus $7 S&H

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

Astronomical League travel mug
$10: plus $4.50 S&H

Coffee mug (ceramic)
$12 plus $6 S&H

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



Astronomical League lapel pin (one-inch diameter)
$8 plus
$2 S&H

Astronomical League full color cloth patch (3" diameter)
$7 plus $1.50 S&H

Canvas tote bag–Royal
$16 plus
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Astronomical League blue and white cloth patch (3" diameter)
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Globular Clusters
$14 plus
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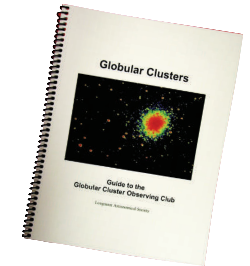
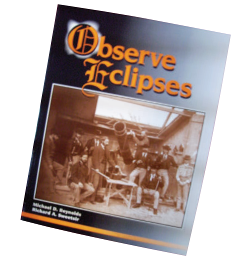
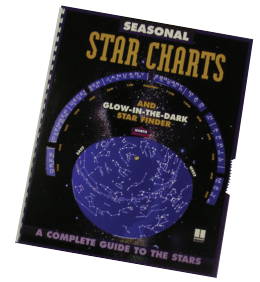


Observe Eclipses
Regularly $18,
Sale price $9
plus $3 S&H

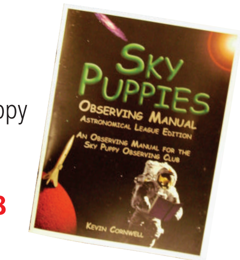


Seasonal Star Chart
$24 plus
$6 S&H

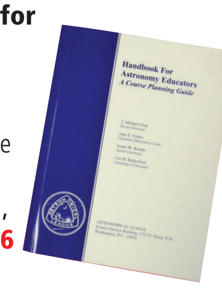


Universe Sampler
$10 plus
$3 S&H

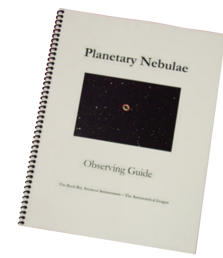
Sky Puppies Observing Manual–
For the Sky Puppy Observers Club
Regularly $15,
Sale price $8
plus $4 S&H



Astronomy for Educators Handbook
A Course Planning Guide
5.5" x 7.25"
Regularly $12,
Sale price $6
plus $2 S&H



Planetary Nebulae
$14 plus
$3 S&H



Observe the Herschel Objects
$6 plus
$3 S&H

Messier Objects: A Beginner's Guide
$8 plus
$2 S&H

Math for Amateur Astronomers
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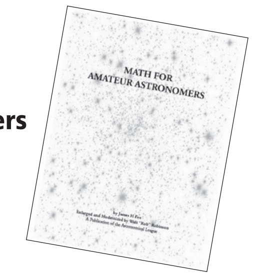
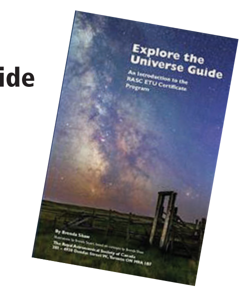
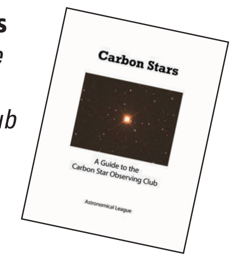


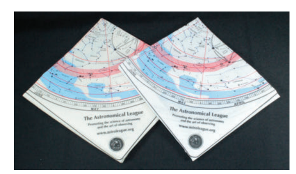
RASC Explore the Universe Guide
$20 plus
$4.50 S&H



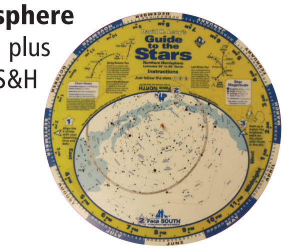
Carbon Stars
A guide to the Carbon Star Observing Club
$12 plus
$3 S&H



Bandana
$12 plus; $2 S&H
Natural or White



"Guide to the Stars" 16" Planisphere
$21 plus
$6 S&H



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