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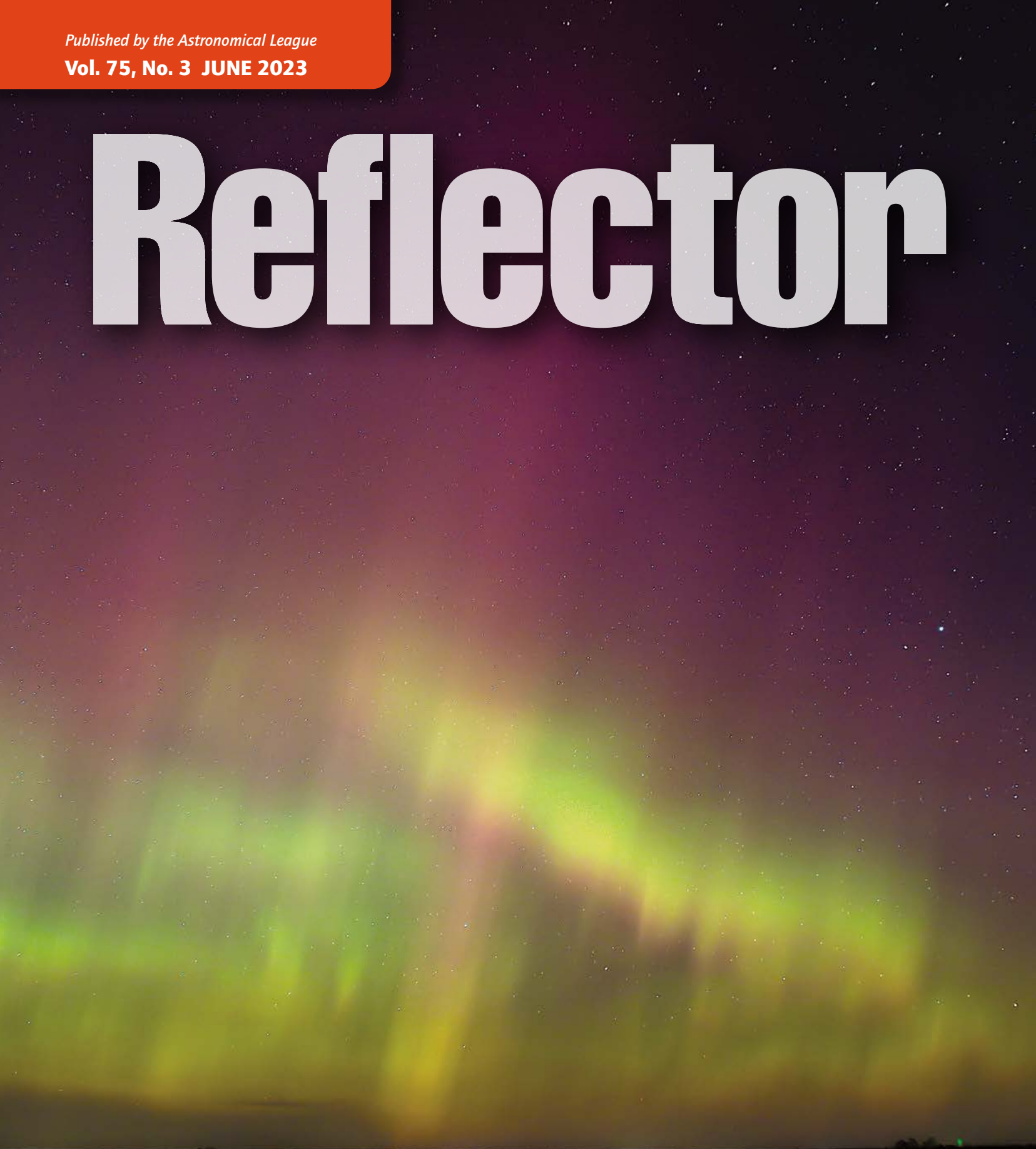
Reflector



A CENTURY OF STELLAFANE

STELLAR PHOTOMETRY FOR AMATEURS

ANCIENT GALACTIC ARTIFACTS

The 87th Stellafane Convention

August 17-20, 2023. Experience the **ORIGINAL STAR PARTY,** held since 1926 at the storied home of the Springfield Telescope Makers.

KEYNOTE ADDRESS

"Adventures of an Eclipse Chaser" by **Joe Rao,** Space.com's skywatching columnist, veteran meteorologist, and instructor and guest lecturer at New York's Hayden Planetarium.

"SHADOWGRAM" TALK

by **Dr. Kristine Larsen,** professor of astronomy and editor of the Astronomical League's *Reflector* magazine.

FINE OBSERVING from our dark Vermont hilltop, with your telescope, the legendary Porter Turret Telescope, the McGregor Observatory's 13" Schupmann Telescope, the Simoni Observatory's Hale Spectrohelioscope, and other modern and historic instruments on our campus.

HOMEBUILT TELESCOPE COMPETITION

Built a telescope? Show it off in front of the historic Stellafane Clubhouse in our mechanical and optical competitions. In the ATM world, nothing beats a blue ribbon from Stellafane!

TALKS, DEMONSTRATIONS, & WORKSHOPS

for adults and children, from beginner to expert.

FOOD SERVICE good hot meals on site.

RAFFLE great prizes, great odds.

SWAP TABLES
strictly non-commercial.

OBSERVING OLYMPICS

TEEN ROBOTICS WORKSHOP

CAMPING on site or stay in local hotels and B&Bs.

The Hartness House Workshop

ECLECTIC ASTRONOMY II

This workshop will offer high-quality presentations on a range of astronomical subjects, and an opportunity to mingle with the speakers and other attendees at the historic Hartness House Inn. **The Hartness/Porter Museum of Amateur Telescope Making** will be open during the day.

The keynote speaker will be Dr. Andrew Boden, Deputy Director of the Palomar Observatory, who will speak about Russell Porter's many contributions to the development of the Hale Telescope. Separate day and evening programs: the evening program includes dinner and keynote. **Registration is separate from Convention,** with additional fees. See the web page at the link below for registration information.

LEARN MORE AND REGISTER ONLINE STARTING IN EARLY MAY AT STELLAFANE.ORG/CONVENTION/2023/INDEX.HTML (OR SCAN THE QR CODE AT RIGHT). REGISTER EARLY FOR BEST RATE!

photo credits: keynote panorama, Thomas Spirock; telescope competition, Richard Sanderson; Hartness House, Tyler Goodrich via Wikimedia Commons; Schupmann Telescope, Dennis di Cicco.

SPRINGFIELD TELESCOPE MAKERS™ 1923 2023 100 YEARS

Probably the oldest existing amateur astronomy club in the world, the Springfield Telescope Makers were founded a century ago, in 1923.

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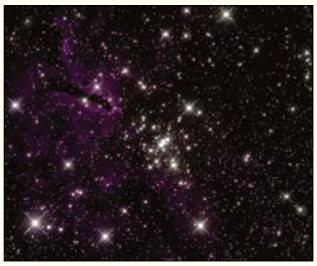

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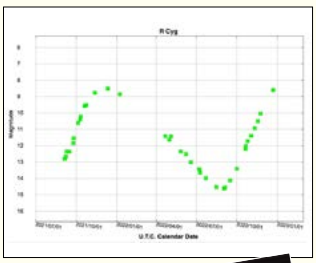

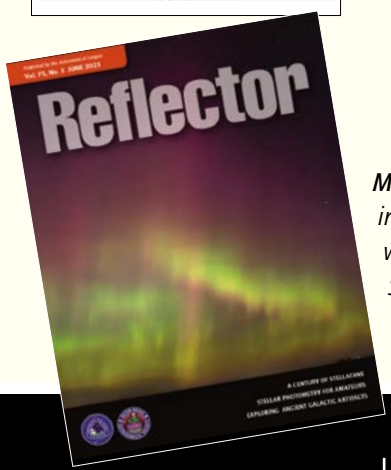

Mark Brown *(River Bend Astronomy Club) captured this image of the aurora on March 24 from Independence, Iowa, with a 20-second exposure using a Canon 60Da and a Sigma lens at 17 mm and f/3.5.*

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

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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DIGITAL SUBSCRIPTIONS:

All countries, possessions, and territories: $10.00 per year

***REFLECTOR* AND CLUB ROSTER DEADLINES**

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

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Send to *larsen@ccsu.edu* with subject line "letter to editor"

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Errata

BEWARE THE ISSUES OF MARCH!

Despite our best intentions, your *Reflector* staff made three notable errors in the March 2023 issue that we need to set aright. Fortunately, we can correct the electronic versions of the *Reflector* posted on the AL website.

First, "The DEB Initiative" article was incorrectly attributed to Matt Penn. It was actually "penned" by Zack Stockbridge, one of the DEB collaborators.

Second, we listed the incorrect email address in Lowell Lyon's article on "Planning Ahead for AstroCon at Bryce Canyon." The correct email address is *bolide@sisna.com;* the corrected article is included in this issue's "Around the League" section. Please send Lowell any ideas you have for the 2025 conference, including presentations and workshops.

Lastly (we hope!) we accidentally switched the illustrations for Figures 3 and 4 in Stephen Maas's "Image Color Calibration" article. The captions are correct. We apologize profusely for our shortcomings, and welcome all eagle-eyed critiques.

To the Editor

In the March 2023 *Reflector*, the image of the M87 black hole in Dave Tosteson's article "Ultramassive Black Holes" got me wondering "What magnification would I need in a telescope to see this?" As it turns out, the answer is about 100 million! The shadow of the black hole is about 100 micro-arcseconds or 1/10,000 arcsecond across on the sky. As seen on the page at a distance of 20 inches from your eyes, the one-inch diameter shadow has a diameter of about 3 degrees or 10,000 arcseconds. So the image on the page is magnified 100 million times from what you would see with the naked eye at night. Continuing this fantasy, if you used a 10-millimeter eyepiece, the focal length of your telescope would need to be 1,000 kilometers. To get decent resolving and light gathering power, a focal ratio of around f/10 would be nice, so your objective would be 100 kilometers across. Maybe possible at some time in space, or using a hypertelescope or the Sun as a gravitational lens.

—Dick Jacobson
Minnesota Astronomical Society

Star Beams

THE NEW AND IMPROVED WEBSITE

By the time you read this, our new website should be operational and ready to give our visitors a much more functional, attractive, and useful site to serve our members' and visitors' needs. I apologize to our membership that this has taken so long to realize! Thanks for your patience with an upgrade that lasted much longer than any of our leadership anticipated. Leaders of other similar organizations have reported similar delays when their groups upgraded their websites.

This has been a positive yet frustrating experience from the time we entertained the idea of spending a substantial sum of money to upgrade our website two years ago. This longtime goal has become a reality, thanks to recent generous bequests to the Astronomical League Trust Fund.

Like many of my colleagues in the League, including our dedicated volunteers and staff members, we have fielded many inquiries regarding why club information was outdated and why we couldn't move faster. Other comments reminded us that information was outdated in several other areas. These were legitimate concerns, and our new, fully functioning website will allow us to advance to the next level of tweaking this much improved site, with easier capability of making changes without worrying about existing custom programming preventing us from doing this.

For the past several years we had dedicated volunteers, as we have now, who did their best to provide the best website they could develop with the limited resources available. In that environment, through no one's fault, we used software that was probably available at a very affordable price, sometimes to the exclusion of having a software package that was more widely used by website developers. Our new WordPress website is a major step forward. As WordPress is one of the most widely used website software packages, we have recruited a solid group of volunteers familiar with the program. We will be utilizing these dedicated and knowledgeable folks to assist us with not only updating any remaining out-of-date content, but also keeping our site populated with current information. On the new website, there will be a specific place for leaving comments about any problems you may find. When a comment is posted, an automatic response will alert the sender and the webmaster of the received comment. We can constantly monitor this for items that need our attention.

We anticipate that with the new capabilities of the WordPress software, we will be able to expand the ability of individual societies to update club rosters and other information online. Much more information will follow in the future.

I would be remiss if I didn't recognize the extraordinary work of our volunteer webmaster, John Martin. John holds a demanding, full-time position in IT, yet he managed to find the time to also function as our point person in effectively communicating with our website vendor throughout this process. Also, past presidents Ron Kramer and John Goss provided an invaluable service of critiquing and evaluating the content and appearance of the new site as we moved through the process.

NEW SPONSOR FOR THE AL SKETCHING AWARD PROGRAM

The League now has a new sponsor for the Sketching Award Program. **Telescope Trader** is the new sponsor, and a separate announcement article appears elsewhere in this issue of the *Reflector*.

ALCON 2023 COMING SOON

I hope to see many of you in Baton Rouge, Louisiana, at ALCon 2023, July 26–29. The committee has assembled a terrific lineup of speakers and special events for your enjoyment.

—Carroll Iorg, President

International Dark-Sky Association

GLOBE AT NIGHT FINDS ALARMING LIGHT POLLUTION INCREASE

Globe at Night is a worldwide citizen-science campaign to raise awareness of light pollution and to provide ongoing measurements of light pollution around the globe. Citizens count stars in various parts of the sky and submit their data, which are used to calculate sky brightness metrics for many locations. It has been an important player in the light pollution battle for years, and I have written about it in the past. Check out its website at *www.globeatnight.org.*

A recent article in *Science* by Kyba and others used Globe at Night data from citizen scientists to "report global rapid reduction in the visibility of stars from 2011 to 2022." In other words, light pollution in getting worse. This is something most amateur astronomers have experienced personally, so this report is not really surprising. What I do find surprising and worrisome is the extent of the loss of star visibility and the rapidity at which it is occurring. Lighting is most correlated with population increase; therefore, it is not unreasonable to expect overall nighttime lighting to increase as population increases, which it has done in most of the world.

However, light-emitting diode (LED) technology has advanced such that it is replacing or has replaced most existing high-pressure sodium, low-pressure sodium, mercury vapor, fluorescent, and incandescent outdoor nighttime lighting in the developed world and in the developing world. LED lighting in general is more energy efficient, lasts longer, and can be remotely dimmed or shut off. Unfortunately, it seems that this increase in efficiency has been transformed into using more lighting since it is relatively less expensive. In most cases, the LED lighting is not dimmed or turned off later in the evening when it is unneeded.

Kyba and others showed "the average night sky got brighter by 9.6 percent per year from 2011 to 2022, which is equivalent to doubling the sky brightness every 8 years." This study was based on 51,351 citizen science observations of naked-eye stellar visibility; this is particularly relevant for us amateur astronomers because it related sky brightness to what can actually be seen. Satellites measure light directed upward and can give precise data for various wavelengths on light emitted directly into the sky from the ground. Current satellites are insensitive in the blue portion of the visible spectrum where much LED light is emitted, and satellites can also only infer data on light emitted horizontally. This may be one reason why satellite measurements indicated scattered light was growing at only 2.2 percent per year. Some horizontally emitted light will eventually be reflected into the sky, but much of it goes directly into the observer's eye or after being reflected eventually ends up in the observer's eye. Blue light is more easily scattered, which will not be noted by satellite observations. Horizontally emitted light is more problematic to the visual observer, and its effects are better estimated by good data from many visual observations like the star counts provided by Globe at Night. You can access the article at *www.science.org/doi/10.1126/science.abq7781.*

Existing policies have not, in most cases, prevented the terrible increase in light pollution documented by the Globe at Night data. A good review of the *Science* paper and its implications for the nighttime sky is found in a recent IDA news summary at *www.darksky.org/new-study-highlights-the-need-for-urgent-action-to-reverse-runaway-light-pollution.* This is an unfortunate wake-up call for us to take more action in the battle against light pollution. It is fair to say light pollution is an urgent environmental threat.

—Tim Hunter
Co-founder, The International Dark-Sky Association, Inc. (IDA)

Night Sky Network

SOLAR SAFETY FOR YOUR EVENTS

It's a great time to be a solar observer! Solar eclipses will soon grace American skies, and the Sun itself has become very active, flecked with intriguing sunspot groups and looping prominences along its limb. If you enjoy sharing these sights – and your safe solar viewing equipment – with others, you've undoubtedly been asked about how safe it is to observe the Sun. It's a fair question: no one wants to be blinded or burned. Plus, many remember the publicity around dubious batches of eclipse shades sold to the public during the buildup to the August 2017 total solar eclipse. The answer is: it is safe to view the Sun, *provided you take appropriate precautions.* The following are a few, but not exhaustive, safety tips to help keep your solar viewing parties safe and fun:

THE BASICS

NEVER look directly at the Sun with your unshielded eyes, sunglasses, through fog or clouds, or through a shield made from dark household materials.

USE ONLY CERTIFIED AND UNDAMAGED SOLAR EQUIPMENT FROM REPUTABLE VENDORS

This is an old drumbeat, but please: ensure your solar viewers come from reputable sources and are undamaged. That includes even small scratches on the filters, since even a tiny scratch can let in a literally blinding amount of light. Ensure your solar viewers (or "eclipse glasses") are both labeled with the ISO 12312-2 safety standard and come from a reputable source. The American Astronomical Society has a list of reputable vendors on their eclipse website: *eclipse.aas.org/resources/solar-filters.*

SUPERVISION IS KEY – THE MORE HELP, THE MERRIER

You're probably well aware of how hectic things can get around the telescope during outreach events. Don't do it all yourself! Daytime events benefit greatly from runners and supervisors who can keep an eye on the people, telescopes, and other equipment to ensure no distractions lead to damages. Plus, this allows you to take critical breaks to rest and stay hydrated. Speaking of which:

STAY SHADY AND HYDRATED

It may sound counterintuitive, but make sure you have a shady spot nearby to rest and hide from the Sun. If you don't have a handy building or tree nearby, see if you can bring or borrow a canopy or some sort of tent to use instead. You won't be the only one to appreciate having a spot to take a break – your visitors will, too. Make sure water and sunblock are nearby. You can certainly get a sunburn while stargazing, if the star in question is our Sun!

REFERENCES FOR MORE ADVICE

NASA's Solar Eclipse Safety Guide: *bit.ly/nasaeclipsesafety*

American Astronomical Society's Eye Safety Guidelines: *eclipse.aas.org/eye-safety*

AAVSO Solar Observing Guide: *www.aavso.org/solar-observing-guide*

It's always good to double and triple check safety guidelines; even an experienced outreacher may be tempted to take a risky shortcut or two. Review the safety tips from NASA, the AAS, and AAVSO, linked above, to help ensure your event's solar safety during both solar eclipses and daytime observing events in general.

A solar viewing area complete with a live video feed from one of the telescopes, next to a shady canopy. As a bonus, a display of meteorites awaits curious visitors! Image credit: Jim Palmer / Astronomy Association of Arizona

CHECK YOUR INSURANCE

It also doesn't hurt to be insured, especially if you will be hosting large events! Many event venues and partners also require proof of insurance. Your club may already have a policy; check with your officers if you are uncertain. You can find information about club liability insurance on the Astronomical League's website at *bit.ly/clubinsurance* or send an inquiry to *leagueoffice@astroleague.org.*

SAFETY FIRST, SAFELY FUN

Sharing the wonders of eclipses and our Sun's magnetic storms is fun and rewarding, but you do need to stay vigilant to ensure your visitors stay safe and enjoy themselves. If you have any questions or want to share your own safety tips, please send us a message at *nightskyinfo@astrosociety.org.* And if you would like to find some solar observing events near you – or even share your own – go to *nightsky.jpl.nasa.gov.*

—David Prosper

DID YOU KNOW:

Our Sun is a variable star in the sense that it has an ever-changing number of sunspots, areas of intense magnetic activity that appear darker than the average surface (the photosphere) because they are cooler and hence less luminous. There are also hotter and thus brighter than average areas called faculae. While one might expect the brighter and dimmer areas to cancel each other out, in the case of stars similar to our Sun the brighter areas tend to dominate on average, except when large sunspots are visible. Therefore, as counterintuitive as it might seem, the overall brightness of the Sun measured over the electromagnetic spectrum (or total solar irradiance) is generally about 0.1% higher when sunspot activity is at its maximum versus minimum, because higher sunspot activity correlates with higher amounts of faculae and other forms of energetic activity. The AAVSO is dedicated to the careful observation of stellar variability in all its forms, including the Sun. The AAVSO Solar Section (*www.aavso.org/solar)* aggregates observations from observers around the world into a monthly Solar Bulletin. Over time, the long-term trends of solar activity become apparent, including the semi-regular nature of the approximately 11-yearlong solar cycle. The AAVSO Solar Observing Guide (available in seven languages) leads the interested observer through the theory and practice of safe solar observing. **—Kristine Larsen, Editor**

Full STEAM Ahead

THE DOCTOR IS IN

In February 1959, cartoonist Charles M. Schulz introduced an illustration of a girl named Lucy van Pelt in a booth offering her expert advice and encouragement to her peers at the bargain rate of 5 cents. This February I felt a little like Miss van Pelt.

For three years, President Russ Brick of the Southern Cross Astronomical Society has been asking for an Astronomical League table at the Winter Star Party. I contacted Mitch Glaze to see about the possibly of hosting an AL merchandise table, all the while knowing that there would be many aspects to consider. Mitch was supportive and got me up to speed on the policies and

methods of running a store table. He worked with Judith Riley to send a selection of the most popular items for sale. Mitch took into consideration that I was giving a talk, "Mastering Observing with the Astronomical Observing Programs," so ample manuals and other great media were selected.

We arrived on vendor setup day and were greeted by Program Director Neal Kleinman and Mr. Brick. We set up on two tables in a large self-enclosed tent, ready to provide League merchandise throughout the week. The attendees let us know how glad they were to see the Astronomical League represented at the Winter Star Party.

My talk went well, and I received many compliments afterwards, along with requests to present this same information to a few clubs' Zoom meetings in the future. Attendees engaged us in conversations about their experiences with the League as they looked over the wares. A few of my Lucy van Pelt encounters were as follows:

Master Observer no. 47, Richard Harshaw, shared with me that his very first AL Observing Program was the Messier Observing Program, when he was in middle school or high school in the early 1970s. He spoke fondly of the observing he was able to do with the help of these programs. I talked with him for a while about the Junior Activities from the 60s and 70s and we talked about the youth who were observing at that time.

I thanked him for sharing his story with me.

Another gentleman commented that he wants to get his club engaged with these Observing Programs. We talked about doing an overview of a program at a club meeting, with the more advanced astronomers ready to help the newcomers. This will help everyone get through the program without getting discouraged. He was encouraged by our discourse and said that he was going to plan his club presentation.

A woman shared that her club is active in outreach in their community but have had trouble engaging with the local college astronomy club. She said that a few emails were sent without receiving a reply, and that they really want to connect with the students. I suggested that the club should host a high school and college student Messier Marathon complete with food, certificates, and giveaways. They should promote it to high school students through the college astronomy department, hopefully interesting the students in college-level astronomy. She said, "I never thought of that. Thanks, I will give it a try."

Many Canadians attend the Winter Star Party, and one said he was an AL member-at-large. He didn't know how to get started on his own and was overwhelmed by the large number of Observing Program offerings. I had printed out two versions of the list to show during my talk, the Observing Programs alphabetical list and selector grid. Using my copy of the selector grid, I showed him that all the information about each program is listed in an easy-to-read grid format. I then showed him the alphabetical listing and recommended that once he picked a few to start with, he could look at the resources available and the specific goal of each of the programs. He thanked me and purchased the last RASC *Observer's Handbook* off the table.

A few individuals bought a manual for an Observing Program and said they would be working on them during the week. Neal Kleinman purchased quite a few items and the last sale after packing up was to Russ Brick, who was going to work on the Planetary Nebula program. He also said, "You going to be here next year, I hope?" "This is my birthday present," I replied. "Looking forward to it," he answered.

I can honestly say it was a great experience; the attendees were so responsive and friendly, and the very helpful WSP staff made it all worth my while. The only thing is, I did not get one plum nickel out of the deal.

—Peggy Walker
STEAM and Jr. Activities Coordinator
MSRAL Regional Representative

Wanderers in the Neighborhood

WHAT ARE LITTLE ASTEROIDS MADE OF?

Minor planets, also known as asteroids, are some of the oldest objects in our Solar System, remaining largely unchanged since its formation. Major planets like our Earth have undergone dramatic changes from impacts and geologic processes, erasing their early histories. Asteroids provide a view of the early Solar System unavailable anywhere else.

The study of asteroids began after the discovery of 1 Ceres in 1801. Asteroids' small size only allows us to view them telescopically as points of light. No surface detail is visible. With larger telescopes, the light from these objects can be broken down into its individual colors, allowing them to be classified by their spectra. These spectral types can be correlated with the types of meteorites that fall to Earth and are recovered.

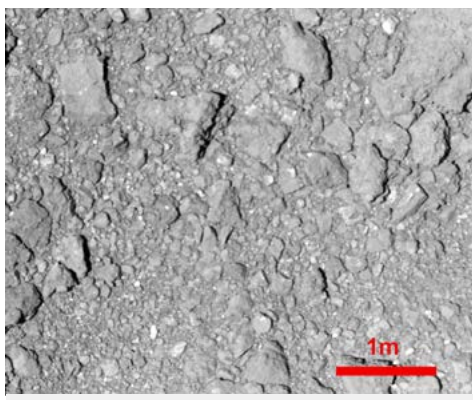
With the launching of spacecraft to the other planets, NASA developed the Deep Space Network (DSN) to communicate with those distant voyagers. In 1968, the Goldstone, California, antenna of the DSN transmitted a radio beam toward the minor planet 1566 Icarus. The reflected radio waves

Minor Planet 162173 Ryugu as seen through the Optical Navigation Camera–Telescopic (ONC-T) on the Hayabusa2 spacecraft. This camera is equipped with seven filters, three of which were used for this color image of the asteroid. Boulders are easily visible on the surface of the 0.624- by 0.544-mile asteroid. This type of asteroid has a bluish cast. Image credit: JAXA/ISAS

formed a radar image of an asteroid, giving us our first view of an asteroid's shape and surface. Over a thousand asteroids have now been imaged this way, providing astronomers with a greater

understanding of the sizes, shapes, and compositions of these objects. Surprisingly, many were found to be binary asteroids, with two smaller asteroids orbiting each other or even temporarily conjoined.

But while these techniques of studying asteroids provided much information, to really understand the details of their composition, samples were needed for laboratory analysis. The Japan Aerospace Exploration Agency (JAXA) conceived a mission to procure samples from the surface of an asteroid. JAXA launched their Hayabusa spacecraft toward minor planet 25143 Itokawa on May 9, 2003. It was designed as both a science mission and a technology demonstration to test the spacecraft's hardware and software as



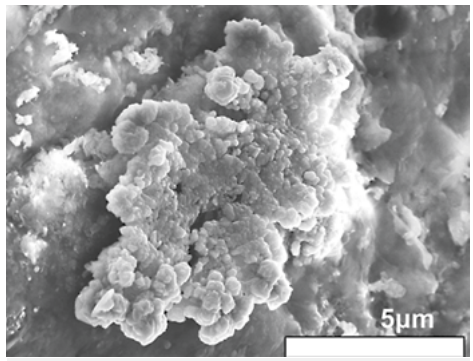
Hayabusa2 took this image of the surface from an altitude of 73 feet with the ONC-T camera. Small rocks of different colors are visible, which may indicate that the surface materials of Ryugu have different origins. The 1m scale bar represents 1 meter (39 inches) on the asteroid's surface. Image Credit: JAXA, University of Tokyo & collaborators

well as the sampling technique.

The spacecraft reached Itokawa in mid-September 2005. As a demonstration mission, it is unsurprising that it faced a number of technological challenges, but it still managed to return a sample to Earth on June 13, 2010. While less than a gram of material was recovered, the mission was a success, and astronomers had their first samples of an asteroid's surface for study.

With the lessons learned from Hayabusa, JAXA launched Hayabusa2 on December 3, 2014, toward 162173 Ryugu, a near-Earth asteroid discovered by LINEAR (Lincoln Near-Earth Asteroid Research) in New Mexico on May 10, 1999. It received a preliminary designation of 1999 JU3. The asteroid is named after the Ryūgū-jō(Dragon Palace) from Japanese folklore.

This asteroid is a rare type Cb asteroid, having properties of both the C-type carbonaceous and the B-type blue carbonaceous asteroids. It is likely a fragment from a collision between its



Analysis of the grains of material returned from the surface of Ryugu has uncovered one grain that has a growth of copper sulfide crystals in the shape of a coral. This image, taken with a transmission electron microscope, shows the root, branch, and disk-shaped crystals. This suggests that Ryugu's parent body may have had an environment in some ways like that of Earth's oceans. Image Credit: Tohoku University

parent body and another asteroid. Post-collision, the larger fragments like Ryugu attracted debris from the collision. These eventually landed on Ryugu's surface, and Hayabusa2 observed them as plentiful boulders and smaller rocks. Ryugu was reshaped again when its rotation sped up, forming an equatorial bulge.

Hayabusa2 made an intensive study of the asteroid between June 27, 2018, and November 12, 2019. It twice sampled the surface of Ryugu and left four rovers behind on the surface. Hayabusa2 then departed the asteroid to return to Earth. The sealed sample container landed at the Woomera Test Range in central South Australia on December 5, 2020. The sample container carried home 5.4 grams of material from the asteroid.

The container was opened at JAXA's Extraterrestrial Sample Curation Center. About ten percent of the sample has been sent to NASA in exchange for material from asteroid 101955 Bennu, another carbonaceous asteroid. This sample was gathered by NASA's OSIRIS-REx spacecraft, which is expected to return the sample later this year. Samples from both asteroids will be available for study by international scientists.

One important aspect they are studying is the effects of space weathering on Ryugu's surface. Space weathering is a process where a surface is exposed to the harsh environment of space. The surface material changes from the action of cosmic rays, solar wind, and meteorite bombardment. These processes slowly change the characteristics of the exposed surface materials.

One tiny sample from Ryugu was distributed to the University of Leicester's School of Physics and Astronomy and Space Park, where researchers took it for analysis to the Diamond Light Source, the UK's national synchrotron science facility, located at the Harwell Science and Innovation

Campus in Oxfordshire in south-central England. There it was examined on the X-ray nanoprobe beamline using X-ray Absorption Near-Edge Spectroscopy (XANES). This process fires X-rays of different energies at the sample to examine how they are absorbed by the sample. Since the absorption is different for different elements, the composition of the sample can be determined.

The results showed that serpentine, a water-bearing mineral on the surface of the asteroid, had lost some of its water into space from weathering. A paper published in the December 19, 2022, issue of *Nature Astronomy* concluded that one effect of space weathering was to make an asteroid's surface appear dry, while abundant water may still be locked in the minerals under the surface.

With the possibility that asteroids in the early Solar System contributed both water and organic molecules to our Earth, understanding the effects of space weathering on Ryugu provides better insight into the interior composition of asteroids. This helps provide a clearer picture of the early Solar System and the formation of the Earth and the life on it.

—Berton Stephens

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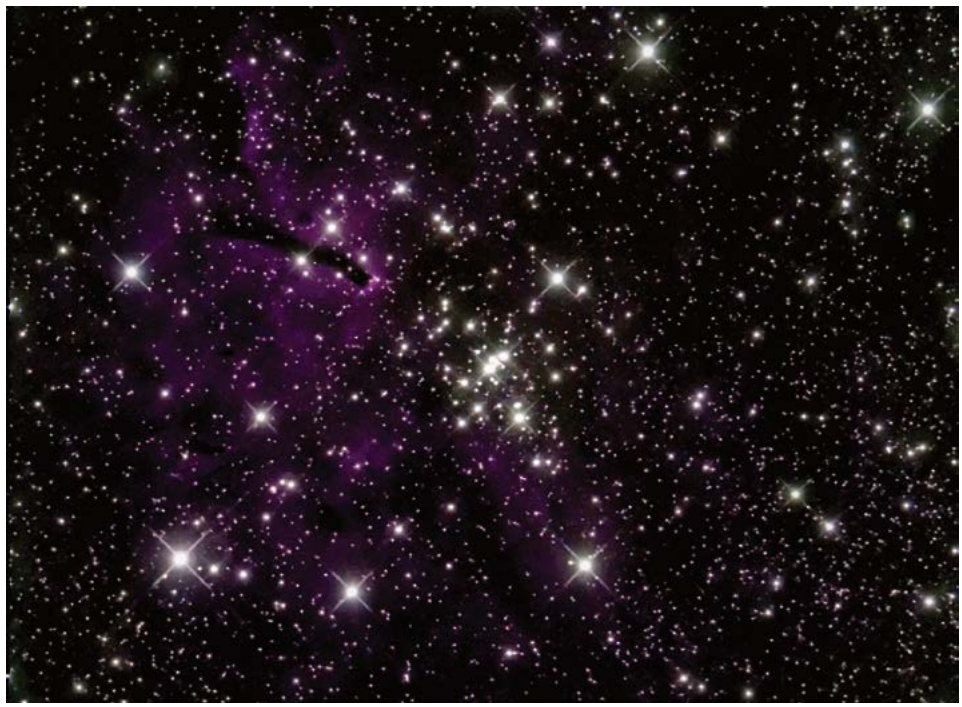
*www.diamond.ac.uk/Instruments/Imaging-and-Microscopy/I14.html*Deep-Sky Objects

Deep-Sky Objects



A FOXY CLUSTER IN VULPECULA

Vulpecula is a small constellation spanning the Milky Way just south of Cygnus. The famous blue-gold double star Albireo lies on the Cygnus side of the boundary between the two constellations. The word *vulpecula* is Latin for "little fox."

Vulpecula can be a hard constellation to spy. First, the constellation has no stars brighter than magnitude 4.44. Second, in dark skies, the glow of the Milky Way almost drowns out the main stars of the constellation. That being said, I have always been able to find objects in the constellation using a red dot finder or an 8×50 finderscope. Of course, a go-to telescope speeds up the process.

The most famous object in Vulpecula is M27, the Dumbbell Nebula. Another popular object in Vulpecula is Collinder 399, a.k.a. the Coathanger or Brocchi's Cluster. The Coathanger is not really a star cluster, but a collection of stars known as an asterism.

Due to its location in the Milky Way, the constellation Vulpecula has numerous small star clusters to explore. One of my favorites is NGC 6823. To find NGC 6823, start at Alpha Vulpeculae, (also called Anser, a magnitude 4.44 star). Then find 4.9-magnitude 12 Vulpeculae, located 5.5 degrees south-southeast of Anser. NGC 6823 is two-thirds of the way along a line from Alpha to 12 Vulpeculae. The cluster is in the middle of the Milky Way practically right on the galactic equator.

William Herschel discovered the open cluster NGC 6823 on July 17, 1785, using his 18.7-inch Newtonian telescope. He described the cluster as being rich in 12th- and 13th-magnitude stars. The cluster contains 92 stars brighter than magnitude 13. NGC 6823 contains numerous hot spectral class O and B stars. The cluster's apparent size is about six arcminutes and it lies 6,000 light-years away. This apparent size corresponds to 18 light-years at that distance.

On the west side of NGC 6823 is an emission nebula, NGC 6820. NGC 6820 was discovered by Albert Marth on August 7, 1864, from Malta using William Lassell's 48-inch f/9.4 Newtonian. This was one of the largest telescopes in the world at the time. Lassell built the 48-inch after successfully building a 24-inch telescope that he used to discover Neptune's large moon Triton.

It is unknown if, when he found NGC 6823, Herschel was aware of the emission nebula Marth discovered. Herschel made no note of the nebula when writing his description of the open star cluster. NGC 6820 is part of a much larger nebula complex known as Sh-2-86 discovered by Stewart Sharpless on photographic plates from the Palomar Observatory Sky Survey. The stars in NGC 6823 formed out of this massive nebula. Today this nebula is still an active star-forming region.

NGC 6823 has an estimated integrated magnitude of 7.1 and is easily seen in an 8-inch telescope. The nebula can be seen in very large amateur telescopes from dark sites.

The accompanying image of NGC 6823 was taken with an 8-inch f/8 Ritchey–Chrétien Cassegrain with a Tele Vue 0.8× focal reducer/field flattener yielding f/6.4. The exposure was 190 minutes using a SBIG ST-2000XCM CCD camera. The brightest regions of the nebula are to the east (left) side of the center of the cluster. Strong solar winds from the hot O and B stars in the center of the cluster appear to have cleared the central region of nebular gases. To the northeast of the cluster (upper left) there is a dark dust lane resembling an elephant's trunk.

Just about all visual telescope users will point their scopes at the Dumbbell Nebula this summer. After gawking at the Dumbbell, hop over a few degrees to NGC 6823 and catch this impressive star cluster. You'll be glad you did!

—James Dire

Around the League

REFLECTOR WELCOMES NEW VOLUNTEERS

We are very happy to announce that three new volunteers are joining the staff of this magazine.

Walter Glogowski will be our new advertising representative. He is a retired high school teacher and avid amateur astronomer. As a teacher, he taught both graphic art classes and astronomy at the high school level. Walter belongs to both the Shoreline Astronomical Society in Holland, Michigan, and the Kalamazoo Astronomical Society, also in Michigan.

Christopher Klein earned his BFA from the School of Visual Arts in New York City in 1991 and works in advertising in the city. He is vice president of the Amateur Observers' Society of New York. He also serves as webmaster for the club and previously produced its newsletter. With this issue, he has begun helping with production for *Reflector*.

Mira Nair, a graphic designer and filmmaker, inherited her love of the night sky from her father, an avid amateur astronomer. She has a BA in design and film from the University of San Francisco, and will be assisting with *Reflector* production tasks starting with the September issue.

BYLAWS REVISION PASSES

Our three-year, COVID-delayed effort to overhaul the League's badly outdated bylaws is now complete. The bylaws revision proposed by the Bylaws Revision Committee and recommended to the membership by the council at ALCon '22 has passed. A total of 364 votes were cast, well beyond the 10 percent quorum requirements of Missouri non-profit corporation law. A total of 354 votes were cast in favor of the revision in its entirety. The remaining 10 votes were cast in favor of the revision except for article VI, section 1, said section passing 354 to 10. The new bylaws will take effect on September 1, 2023, and will appear on the League website at that time.

Among the most important new features are (1) a restructuring of the League's election procedure to address cases in which no candidate appears on a ballot or a ballot candidate becomes unable to serve and to eliminate the possibility of conducting elections in business meetings, (2) the articulation of more flexible and better-defined limitations on the trustees' use of trust fund principal, and (3) a change in the weighted votes assigned to member societies.

Regarding the last change, clubs previously received one vote for their first 10 members and one vote for every full complement of 25 members beyond that. Now clubs will receive one vote for every complement of 10 members, or part thereof, beyond the first 10. This assigns roughly 1,000 additional votes to our 310+ member societies and corrects a severe imbalance in voting power that had developed between the members of League societies and independent League members (for example, members-at-large or lifetime members). This correction brings the relative voting power of the two groups in line with the dues paid by each.

Additional amendments may appear on the annual officer election ballot.

—Chuck Allen
Chair, Bylaws Revision Committee

NEW SPONSORSHIP FOR THE ASTRONOMICAL LEAGUE SKETCHING AWARD

I am pleased to announce a new sponsorship for our Sketching Award Program.

Telescope Trader and I have reached an agreement on funding this important annual sponsorship program. The company is an independent community of astronomy enthusiasts, buyers, sellers, and proprietors. Find this company on the internet at *TelescopeTrader.com.*

Thanks to Telescope Trader for their generous commitment to the Astronomical League's Sketching Award Program!

—Carroll Iorg, President

OFFICER CANDIDATE BIO

TERRY MANN, CANDIDATE FOR SECRETARY

I am currently secretary of the Astronomical League and have past service as League president (2006–2010), vice president (2002–2006), and secretary (1997–2001). I also serve as chair of the Great Lakes Region (2018–present) and as a League trustee (July 2017–present). I cochaired both AstroCon 2011 at Bryce Canyon National Park and ALCon 2021 Virtual and received the G. R. Wright Service Award in 2004. I also received the Great Lakes Region's Hans Baldauf Award for contributions to astronomy in 2007. Serving as secretary during the past year, I have had the pleasure of again working with friends I have known for years and of making new friends.

I have worked very hard to help the League develop its strong virtual presence, working closely with Scott Roberts of Explore Scientific. Starting in December 2020, Scott and I have cohosted monthly League Live events that feature speakers, night-sky imaging, and talks on League events, awards, and Observing Programs. Two

years later, Astronomical League Live is still going strong. For over two years I have also coordinated the League's regular weekly participation in Explore Scientific's widely viewed Global Star Parties.

The pandemic taught us how to communicate in a different way. Although it is wonderful to meet face to face, many people still are not able or willing to do this. We have held conferences and council meetings taking advantage of all the virtual options we have open to us. This has allowed us to include members who would not otherwise have been able to attend these events and has given us the beginning of a global presence that we want to see grow. As we look ahead, I want to see the League continue its efforts to be more accessible to people with disabilities, to become more gender and ethnically diverse, and to attract youth and international members.

PLANNING AHEAD FOR BRYCE CANYON IN 2025

AstroCon 2025 will be held June 25–28, 2025, under the spectacularly dark skies of Bryce Canyon National Park in southern Utah. The venue will be Ruby's Inn and Convention Center a few miles from the park entrance. A special area a few miles east of the convention center will be available for evening viewing plus astrophotography and digital imaging workshops.

The convention's goal is to offer enhanced personal viewing experiences and opportunities to learn astrophotography skills. We are still in the planning stage and we welcome your input on how daytime or evening presentations and workshops can best achieve these goals. Ideas that our committee is considering include:

- **Setting up personal observing programs**
- **Astronomical League Observing Programs**
- **Observing tips**
- **Using star charts (digital and paper)**
- **Creating observing lists for different types of objects**
- **Understanding eyepiece selection**
- **Using filters for visual and photographic work**
- **Sketching workshop**
- **Observing log workshop**
- **Astrophoto/digital imaging workshops (novice and advanced)**

Please contact me if you wish to offer a presentation or coordinate a workshop. We are starting our planning early, but we learned from AstroCon 2017 at Casper, Wyoming, held during the total solar eclipse, that advance planning is important for this type of event. We look forward to hearing from you.

—Lowell Lyon
AstroCon 2025 Chair
801-699-7283 bolide@sisna.com

FIRST WINNER OF THE ASTRONOMICAL LEAGUE'S "TRIPLE CROWN"

At the end of February, Astronomical League Member **Mark Simonson** earned the Master Observer – Platinum Award. Mark previously earned the Master Imager Award and the Binocular Master Observer Award, allowing him to become the first person to obtain the Astronomical League's version of the Triple Crown (or hat trick if you prefer)! Mark is very active in the Astronomical League and the wider astronomical community. He is the current coordinator for the Local Galaxy Group and Neighborhood, Hydrogen Alpha Solar, and Mars Observing Programs. He is also a member of the Olympic Astronomical Society, Island County Astronomical Society, and Everett Astronomical Society, where he serves as their AL coordinator. Mark is also a director for the Table Mountain Star Party and maintains his permanent observatory on Camano Island, Washington.

The first Observing Program developed by the Astronomical League was the Messier Observing Program, in 1967. Today more than 2,900 members have received this award. Since that time, the AL has added many other observing programs to the list. In 2001 the League created the Master Observer Award for people completing five required programs and five elective programs. At the time of this writing, 258 Master Observer Awards have been earned. In 2016 the League created the Master Observer Progression, adding multiple levels of mastery, including master-level awards for binocular observing and imaging. There are currently eight different progression awards that can be earned. Mark Simonson has received all eight of these progression awards. Congratulations, Mark!

—David Whalen

THE SPRINGFIELD TELESCOPE MAKERS CELEBRATE A CENTURY OF AMATEUR ASTRONOMY

The Springfield Telescope Makers (STM) invite you to join us in celebrating the centennial year of our founding, at this summer's Stellafane Convention, August 17-20, 2023. This year also marks 100 years since the start of the construction of the revered pink Stellafane clubhouse on Breezy Hill, built by the founders of the STMs. If you have not been to Stellafane in a while or have never attended the annual convention, this would be a great year to join us. We'll have numerous presentations from novice to advanced, special child and teenage programs, and of course the telescope competition, which is the heart of the Stellafane Convention experience.

Although the Stellafane Convention is often simply referred to as "Stellafane," the name properly belongs to the Springfield Telescope Makers' venerable pink clubhose, built a century ago on Breezy Hill. Photo credit: Michael Patterson

Russell Porter grinding a telescope mirror. Photo credit: Stellafane photo archives, courtesy of Bert Willard

Stellafane's roots go back to 1920 when Russell Porter offered a telescope making class to some employees of the Jones & Lamson Machine Company in Springfield, Vermont. This is widely recognized as the origin of organized American amateur telescope making as this group learned how to craft fine instruments, and to use them to enjoy the sky, democratizing astronomy.

Porter obtained his architectural degree from MIT, then joined Robert Peary for several arctic voyages as an artist and surveyor. He eventually settled in Port Clyde, Maine. While there he founded an art colony, designing a number of homes for this endeavor. Porter had been enthralled with astronomy since childhood, and had made telescopes to observe the night sky, grinding, polishing, and figuring the mirrors. At Port Clyde he perfected his telescope-making skills, and hosted local meetings of amateurs there. He also published several articles on telescope making in *Popular Astronomy*.

In 1919 Porter was recruited to come back to Springfield by James Hartness, to develop an optical comparator into a marketable product for Jones & Lamson. He successfully developed this instrument, which is used for precisely measuring machine parts, and received a patent on it. He stayed in Springfield until 1929, when he was hired by George Hale to work on the 200-inch telescope project.

On August 17, 1920, fifteen men and one woman signed up to learn how to grind their own mirrors and make reflecting telescopes. Most of the men were machinists, tool makers, or pattern

The Milky Way and a Perseid meteor over the historic Porter Turret Telescope at Stellafane. Photo credit: Dennis di Cicco

makers at the plant; the lone woman was a school teacher. James Hartness, who had built his own turret telescope, supported Porter's efforts by providing space in the J&L plant.

The group met monthly, and eventually decided to incorporate as a club, the Springfield Telescope Makers, which was formally chartered on December 7, 1923. Their achievements attracted the attention of Albert Ingalls, the editor of *Scientific American,* who published a series of articles about them, and the group's fame spread across the country, cementing Stellafane's place in American astronomical history.

In 1923 the group began building a clubhouse on Breezy Hill on the outskirts of the town for their telescope making activities and observing. Completed in 1924, the clubhouse was painted with what may have been donated surplus paint mixed into one batch, resulting in a pink mixture. Member meetings have been held ever since at the clubhouse, at first called Stellar Fane, then shortened to Stellafane. The annual convention, begun in 1926, has occurred almost every year (except during World War II and during the COVID-19 pandemic in 2020). The conventions have grown in popularity, drawing amateur astronomers from around the country, Canada, and even overseas, allowing amateurs to show off their homemade telescopes and share a love of astronomy. (Of course all telescopes, homemade or commercial, are welcome for observing.) The spirit of Porter and the founders lives on through these conventions.

The original Stellafane site (including the clubhouse and the Porter Turret Telescope) was designated a National Historic Landmark in 1989 for its historical significance in the popularization of amateur astronomy. The Springfield Telescope Makers now own a significant piece of adjacent land with ample camping space for the conventions. The grounds have been developed and now boast a large roll-off observatory with a 13-inch Schupmann telescope, among others. There is a large meeting hall for the talks, the Flanders Pavilion, to protect attendees from inclement weather or harsh sun. There is an excellent program of talks at all skill levels including activities and sessions for children and teens. The highlight is the Saturday night program with a featured prominent guest speaker, and the presentation of the telescope-making awards.

True to the founders' mission, the awards for excellence in telescope making are the heart of the convention. To win a coveted Stellafane award – offered in several categories, including optical, mechanical, and craftmanship – brings great pride and a sense of accomplishment. Stellafane remains an amateur event, as no commercial displays of any kind are allowed.

The Stellafane Convention has become a yearly family event, with many attendees bringing children and grandchildren with them. I am happy to have my children and grandchildren as attendees every year, and they have made lifelong friendships with other Stellafane families. Though there are local hotel rooms, camping is the best way to experience both the daytime activities and nighttime observing. Go to *stellafane.org* to read more about the rich history of the STMs and Stellafane, and to register for the convention. On this 100th year gathering, join us for a grand celebration of telescope making and observing. Bring your telescope to observe, or even better, enter your homemade telescope for recognition. Come join the Stellafane family, meet like-minded amateurs, and renew old friendships.

—Mario Motta, MD
Springfield Telescope Makers

Part of the crowd in the Thayer Amphitheater for the Saturday evening keynote program. Photo credit: Dennis di Cicco

ASTRONOMY OUTREACH IN THE BADLANDS

The summer of 2022 at Badlands National Park, South Dakota, was a marvelous experience. We served as National Park Service (NPS) Volunteer Rangers. It was a fantastic opportunity to explore the wildlife, geology, and fossils, and most certainly for our astronomy outreach program.

Our main role was working on the Astronomy Team and giving the Night Sky Program from Memorial Day to early October. The program was held nightly in the park's Cedar Pass Campground Amphitheater. Our program started with a short slide presentation. We then pointed out constellations (including Lakota Native American constellations), stars, and planets. These activities led to the program highlight, observing the heavens; the telescopes were provided by the Night Sky Program and Celestron.

photos courtesy of the authors

Of special note were the dark skies and the brilliance and clarity of the Milky Way. A sizable portion of the over 11,000 program participants were seeing the Milky Way and planets for the first time due to many of them being from large cities where light pollution is an issue. Their enthusiastic responses to the majesty of the heavens were endearing and incredibly rewarding.

An additional activity was the Annual Badlands Astronomy Festival. This was a three-day celebration (late July in 2022) that brought together space science professionals and educators. Events included family-friendly daytime activities and evening presentations, including some remarkable telescope viewing.

The Badlands is near other interesting scientific sites including the Badlands Observatory in Quinn, South Dakota, and the Sanford Underground Research Facility in Lead, where scientists are detecting neutrinos from the universe. Other NPS sites are nearby, including Mount Rushmore, Wind Cave, Jewel Cave, and Devil's Tower.

League members looking to support astronomy outreach can find information at the NPS website, *www.nps.gov.* Contacting a specific park is also suggested.

We are most grateful for the visitors we encountered, the camaraderie of Astronomy Team members, the steadfast support of Badlands National Park staff, and the constant encouragement of family and friends.

—John and Kathleen Strebeck
St. Louis Astronomical Society

[Your Name Here]-1

By Brad Young

One of the joys of sweeping the night sky is the plethora of lines, figures, and shapes seen in the star fields. Many groups of stars that you see aren't among the official constellations and are called asterisms. Some are large enough to be seen with the naked eye, and others show up best in a telescope. Quite a few are listed in books and other references, and you probably know many of them already. For instance, the Big Dipper is an asterism. It's part of the constellation Ursa Major, but it's not actually a constellation itself. The shape we see as a dipper has been seen by many cultures over time, and given different names and mythology, but the constellation itself includes more stars, and even another asterism, Three Leaps of the Gazelle [1]. Of course, people see different groups in their own way even today. Asterisms may be generally known or published, parts of obsolete constellations, or unknown (except for in the eye of the beholder). The following examples might encourage you to look for these groups, or sweep along in the sky, making up your own as you see interesting shapes.

LITTLE BOX AND LAWN CHAIR

Over the years, I have found dozens of beautiful little fields and groups and have a few favorites, many from satellite hunting. One is what I call the Little Box. This group of four stars first drew my attention because it is near the First Point of Aries, where the Sun is located at the spring equinox. Later, I learned it is also part of an extinct constellation called Testudo, which was shown on star atlases and maps in the West until it was removed with the adoption of the 88 official constellations in 1930. Testudo the Turtle consisted of what I call the Little Box plus a few more stars to the east along the Pisces–Cetus border. The star at the southwest (bottom right) is 30 Piscium.

The Little Box is especially useful to me because geosynchronous satellites flare up and become easy to see in autumn. For my latitude, they appear to pass right through the box during early October. I had noticed it long before my interest in satellites, but now I use it to find them every fall. Now that I know its history, I enjoy it all year long.

On the other side of the sky, there is a group of four 7th-magnitude stars in Sextans (10h 21m, –5°) that looks like a lawn chair, and I use it for the same purpose, as the flaring satellites pass right through or right next to it. I like to think it is a stellar version of the lawn chair where I sit while I look at it. As far as I can find, this is a "Brad" group – not published by others.

UNDER THE SEA (AND GROUND)

Other groups abound, such as 67, Kappa, Upsilon, and 72 Tauri just above the Hyades. It's a group of four stars that look a bit like a shrimp. This winter, Mars passed by this group three times during its opposition loop. John Chiravalle includes this as part of his asterism the Fishhook in *Pattern Asterisms,* but I see only this part, and as a shrimp. There are many asterisms and former constellations [2] with this common shape, such as Gryphites (Shellfish), Hippocampus (Sea Horse), Hirudo (Leech), and Patella (Limpet), to name a few.

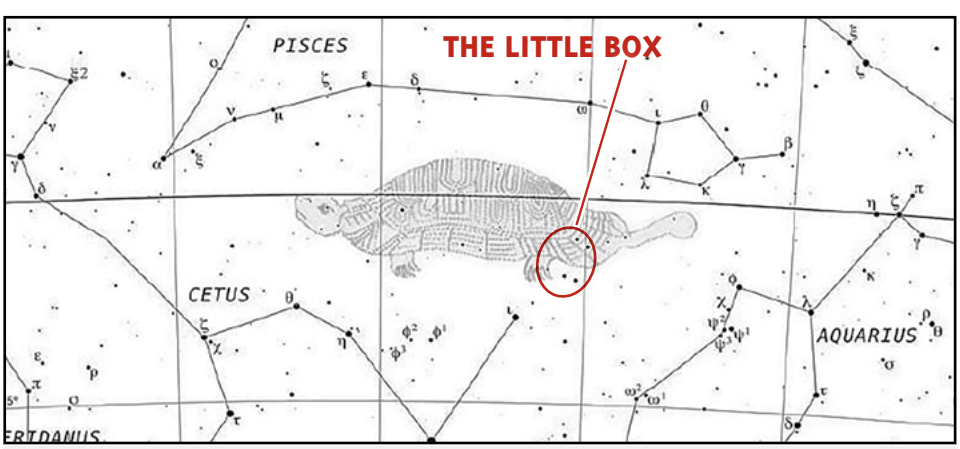
It also resembles the star cluster Melotte 31, also called the Flying Minnow, that is near AE Aurigae, a runaway star (a star with high proper motion) that lights the Flaming Star Nebula. The group is hard to miss on your way to that object. AE Aurigae is at the upper right, with its nebula, and the bright star at the south end of the Minnow is 16 Aurigae.

All of these resemble Delphinus, the Dolphin, an official constellation which includes its own asterism, Job's Coffin[3]. This asterism is the diamond shape formed by the four bright stars in the head of the Dolphin.

SNAIL AND A SLICE

Terebellum [4] in southeastern Sagittarius is another group, named by Ptolemy, that is not a constellation itself. It consists of four stars (59, 60, 62, and Omega Sagittarii) and is near M55. Named for a snail (I don't see it), the Chinese had another idea, and called it Dog Territory. It was included in their wide collection [5] of groupings in modern Sagittarius.

Just north of Gamma and Delta Capricorni is a little group of four or five stars that looks a bit like a slice of pizza. This little group is made up of 42, 44, and 45 Capricorni and a few others. In 2022, Saturn was moving through it during its opposition. Classic star charts [6] usually show only 42 plotted (as "d" in this case) and it does not appear to be a known group. And it must be plain cheese, as there are no stars inside the group for toppings. *Note – some sources* [7] *list the Summer Triangle as the Pizza Slice,*



The deprecated constellation Testudo superimposed on a star chart. Image credit: "Ultima Thulean" via Wikipedia, Creative Commons Attribution-Share Alike license, with annotations added by Reflector *staff.*

but the original name is well established.

There are innumerable other little groups all over the sky – it would be easy to find groups of your own that resemble a bird or a box or some other object that you can easily remember.

ALTERNATE VIEWS

Another way of viewing these groups is to see how other cultures have viewed them, in both location and time. The stars were a fundamental part of the mythologies and philosophies of all countries, empires, and even prehistoric tribes. At my website, view information on the Alternate Constellations Observing Program [8] and see the list of resources there on cultural astronomy. There are also programs [9] on asterisms and the official constellations to help you enjoy our sky more. You may find your favorite group there, as an obsolete constellation or an ancient Akkadian warlord.

BUILD YOUR OWN CATALOG

In the same way, the deep sky can contain individual objects that only you "know about." One of my favorite sights is the dark nebula leading to the Cocoon Nebula in Cygnus. I start by viewing it naked eye (in a very dark sky) before zooming in on the nebula itself with the telescope. I learned about this method when I first began observing and discovered the field surrounding NGC 6871 and 6883 along with Biurakan 1 and 2 in Cygnus. Although the area contains cataloged open clusters, back then I didn't have good charts (or a computer). It seemed to me that the loop-de-loops, wide double stars, and connecting lines and whorls of stars between all of these objects was something that only I knew about. I returned to that field repeatedly to enjoy the interaction between the clusters and the Milky Way surrounding it.

Sweeping the sky and star fields surrounding a target object is often as rewarding as the target object itself. There's a lot of interesting stuff out there that may not be cataloged, but it's beautiful nonetheless and near objects that you're looking at anyway. The next time you're observing, look around your object and see if there's not a neat clump of wide double stars or a line or circle of colorful field stars. If no one's looking, you can catalog them as [Your Name Here]-1. ✶

NOTES

Additional information and Images of many of the asterisms mentioned in this article can be found at the following links:

[1] *rocketmime.com/astronomy/fig/UrsaMajor.gif.*

[2] *en.wikipedia.org/wiki/Former_constellations*

[3] *astronomy.com/magazine/phil-harrington/2020/09/a-dolphins-tale*

[4] *en.wikipedia.org/wiki/Omega_Sagittarii*

[5] *en.wikipedia.org/wiki/Dipper_(Chinese_constellation)*

[6] *upload.wikimedia.org/wikipedia/commons/f/fc/Sidney_Hall_-_Urania%27s_Mirror_-_Capricornus.jpg*

[7] *twitter.com/astrogeo/status/1297682343939858432*

[8] *hafsnt.com/index.php/alternate-constellations/*

[9] *www.astroleague.org/al/obsclubs/AlphabeticObservingClubs.html*

ADDITIONAL RESOURCES

The Lost Constellations, John C. Barentine ISBN 978-3-319-22794-8

Uncharted Constellations, John C. Barentine ISBN 978-3-319-27618-2

Pattern Asterisms, John A. Chiravalle ISBN 978-1-84628-327-7, p.53

OKIE-TEX 2023

SEPTEMBER 8 - 16 • BLACK MESA, KENTON, OK.

WE'RE TURNING 40. CELEBRATE WITH US UNDER BORTLE 1 SKIES!

Camp Billy Joe in the Oklahoma Panhandle has long been home to one of the nation's top amateur astronomy events: the Okie-Tex Star Party.

2023 is our 40th anniversary and we're hoping it's the best one yet!

The Okie-Tex Star Party is a week of some of the darkest skies in North America. The days are filled with first-class speaker presentations, a multi-day astrophotography workshop, swap meets, and plenty of attractions within driving distance.

Hope to see you in the Mesa!

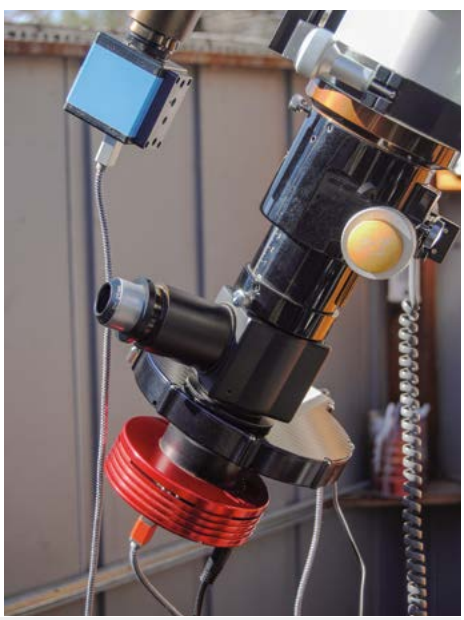
FIND OUT MORE & REGISTER AT WWW.OKIE-TEX.COM

Photo by Andy Fryhover

FURTHER ADVENTURES OF A STARLIGHT DETECTIVE

By Jamey Jenkins

The June 2018 *Reflector* carried the story of my initial experience in the world of low-resolution spectroscopy. Outlined at the beginning of the article was my goal of pursuing photometry of variable stars, but choosing to take a slower approach to first educate myself on the fundamental properties of stars. It was a decision that led me to explore slitless converging beam spectroscopy with the venerable Star Analyzer (SA100) transmission grating. That journey was successful in that I developed certain techniques necessary for photometry, as well as a better understanding of astrophysics.



The business end of the author's 102 mm telescope with a flip mirror diagonal, electronic filter wheel with photometric filters, and an Atik 314L+ monochromatic CCD camera.

Following that introductory foray, I continued my adventure into citizen science and for several years I have been obtaining photometric measurements for the AAVSO (American Association of Variable Star Observers) International Database. For me this has been a rewarding and fun avocation that contributes real science to variable star astronomy. The following paragraphs will describe how one can initiate this fascinating activity, fulfilling an aspiration of all citizen scientists: to observe with a purpose.

DIFFERENTIAL PHOTOMETRY

There are several types of photometric processes including "absolute photometry" and "differential photometry." Absolute techniques use standard fields to calibrate your camera's photometric response and apply that to subsequent images. Differential photometry is the comparison of the difference between a variable star and several known-magnitude comparison (comp) stars in the same field of view. Almost all amateur astronomers use differential techniques.

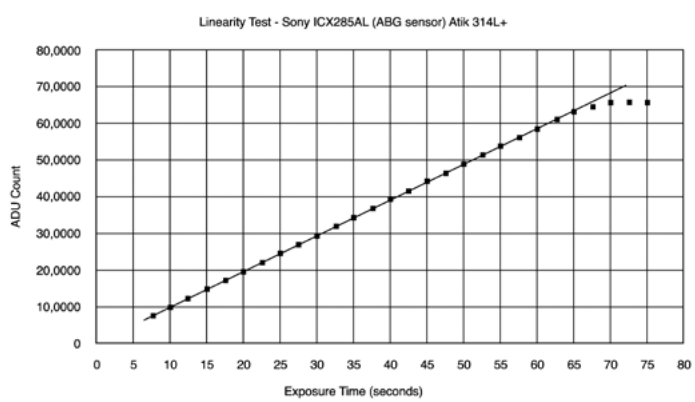
Basically, the observer obtains a raw image containing both the target and comp stars with a camera (CCD, CMOS, or DSLR) of known parameters. It is important to not apply any type of image enhancement algorithms as that would manipulate the photometry data obtained with your camera. That image is calibrated using available software with dark, bias, and flat frames. This calibrated science image is then imported into photometry software and the difference between variable and comp stars measured to determine the variable's instrumental magnitude. Over time, a light curve can be formed from acquired data illustrating the period and magnitudes of the variable star.

I use a vintage Atik 314L+ mono CCD camera with a 102 mm refractor for photometry, although modern CMOS and general photography DSLR cameras are popular options for many observers. Detailed instructions for selecting or using a camera for performing photometry are beyond the scope of this article, but whatever camera–telescope combination an observer has on hand can be a suitable place to begin learning photometry. The best source for in-depth instruction I've found is the *CCD/CMOS Photometry Guide* and the *DSLR Observing Manual* located on the AAVSO's web pages *(www.aavso.org)*.

GETTING STARTED

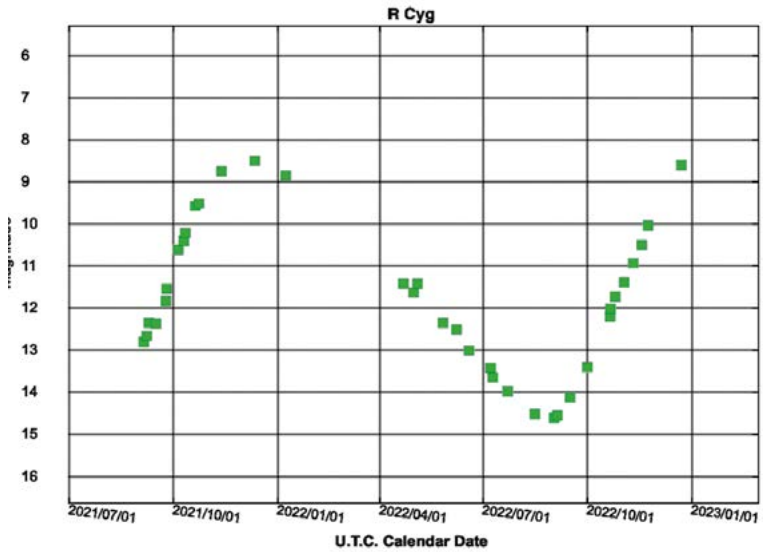
It is necessary regardless of the available equipment to first determine the linearity response and saturation limit of your camera. Saturation can simply be explained as overexposure of a star. That is, too much light from a star has fallen on a pixel resulting in that pixel not reporting a true ADU (analog-to-digital unit) value. These ADU counts are used to determine star magnitude. When graphed, linearity response illustrates whether a camera's sensor responds in a continuous, even manner.

Determining the linearity and saturation limits of your camera's sensor is a straightforward procedure requiring only an evenly illuminated light source and your camera attached to your telescope or to a lens which is pointed at the light source. The image cap-



Linearity and saturation limits are determined from a graph created by taking ADU counts of a flat illuminating panel. As exposure increases, ADU values increase. Eventually, more exposure will not increase ADU and the counts flatten out (upper right plots). This camera's sensor reaches saturation near or above exposures yielding an ADU of about 60,000.

ture or preview software must be capable of reading the ADU value of an exposure; most software has that ability. A series of increasing exposures are taken of the light source with the resulting ADUs plotted on a graph versus the exposure time. Eventually the pixels will become saturated and the measured ADU values stop increasing; that indicates the saturation point. A line drawn through the points shows the linear response of the sensor; a smooth transition to the saturation point is desired. To be measured via differential photometry, a star's ADU value must not be saturated and must fall within the sensor's linearity range.



Light curve from AAVSO V-filter data for variable star R Cygni from mid-September 2021 through end of December 2022. Credit: courtesy AAVSO.

OTHER EQUIPMENT

Most targets require the use of photometric filters (B, V, Rc, Ic). Exceptions could be an exoplanet's transit and establishing the thresholds for other transient events. However, filtered photometry does provide meaningful astrophysical information because stars can vary in spectral characteristics when viewed through different filters. Astro-imagers can begin with a green filter that transforms to a Johnson-Cousins V-filter reasonably well. Most amateur astronomers make use of photometric Johnson-Cousins filters; Sloan filters are another option if Johnson-Cousins filters are unavailable.

Photometric filters limit the wavelength range of the light reaching the camera sensor to well-defined standard bandpasses. The photometric V filter is the best selection if you are limited to one filter; this filter closely approximates visual observations. A good second choice is the B filter (as in B–V color indices). Of course, photometric exposures through different filters will vary; the B filter generally requires twice the exposure time as the V filter.

A filter wheel or drawer would be handy if multiple filters are used. If possible, an electronic filter wheel is desirable. I used a manual wheel for a time, but tended to nudge the field of view slightly each time I rotated a filter change. The electric wheel works hands off to avoid accidentally moving the telescope.

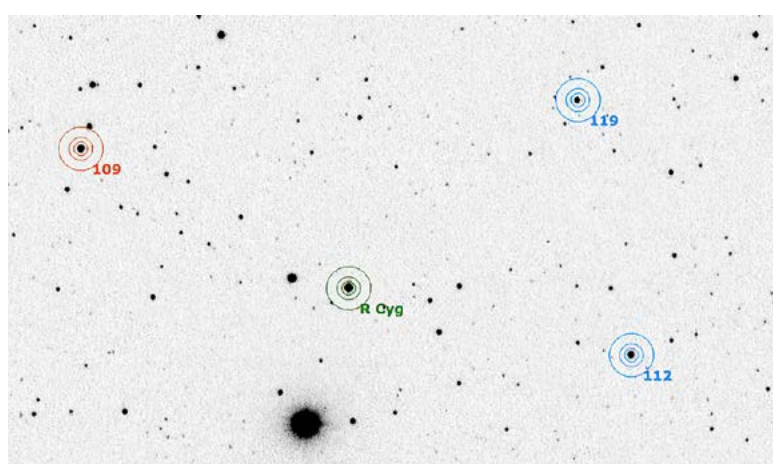
To save time when observing, I invested in a go-to mount for my telescope. Sometimes locating a variable star with a push-to mount can be frustrating, particularly in a crowded Milky Way field. While not a necessary accessory, go-to has added to my pleasure and productivity under the evening sky.

FIRST TARGETS

Opinions vary regarding what targets are most suitable for beginning photometry. One option for a novice is to reach out to various AAVSO Observing Sections for lists of targets for the beginner. I was advised that long-period variable (LPV) stars could be a good starting point, and once I mastered the basics, then I could branch out to whatever interests I might develop. The logic with LPVs as a learning target is that the stars do not require a high cadence of observations. In variable-star lingo, cadence is the time between successive observations by an observer. The recommended cadence of a typical LPV is on the order of one observation per week; no pressure to repeat observations is encountered. Many LPVs are also well observed, and a new observer can often compare measurements to those of other observers as a check for accuracy – a definite plus when developing new skills.

Additionally, there are abundant LPV stars throughout the sky. The magnitude range and period of variability for LPVs is broad, from naked eye brightness to the limiting magnitude of your telescope with some variability periods of more than a thousand days. One hundred days is typical.

I've found that target selection is determined by several factors, including your equipment and observing circumstances. It's important to consider the limiting magnitude of your telescope, filter, and camera setup; the declination (north and south) of visible sky from your observing site should also be known. Trees and buildings can block views during certain parts of the evening, and that must be taken into consideration. Targets that are 30 degrees or more above the horizon avoid problems with atmospheric extinction and seeing. One excellent tool for determining possible targets for an evening of observing is the AASVO Observation Planner *(www.aavso.org/observation-planner-tool)*. Plug in the type of stars you wish to observe and parameters for your observing session (taking into consideration the observing window visible from your site) and the software provides a list of suitable targets for observation. →



V-filter image from November 23, 2022, as it appears in VPhot software. Measurement apertures surround variable R Cygni (green), check star 109 (orange) and comparison stars 112 and 119 (blue).

DOING PHOTOMETRY

Some degree of experimentation and development of a workflow was necessary for my LPV observing program. Preliminary test runs with my equipment on stars of known magnitude gave an *approximation* of exposure for specific magnitude and filter combinations. When doing actual photometry I call on that info, then make a *test* exposure of the variable/comparison star field, measure directly the variable's ADU count, and if necessary adjust the exposure. I then collect several consecutive *science* exposures of that field to ensure I obtain at least one good quality exposure. Problem images can have trailed stars; satellite, meteor, or aircraft passages; cosmic ray strikes; or poor focusing. Short exposures of ten seconds or less require stacking multiple good images to reduce the effects of scintillation. If multiple good-quality long-exposure images are obtained, they can be stacked to improve the signal-to-noise ratio (SNR) of the final image.

Experience will ultimately lead to the creation of a workflow suitable for your equipment *and* target selection. For instance, photometry on some of the brighter stars with large telescopes can use images of appreciably short exposure requiring particular attention to atmospheric effects. Practice makes perfect in this work.

Capturing variable star images at the telescope is only half of the photometry workflow. The initial images must first be calibrated with bias, dark, and flat frames to remove camera noise and provide a smooth, evenly illuminated picture. Images are saved in FITS (Flexible Image Transport System) format, which is widely used to store, transmit, and manipulate scientific images and data.

Various software packages (for example, MaxIm or CCDSoft) are available for photometry. However, membership in the AAVSO includes use of their online photometry software VPhot, a powerful tool for data reduction. When measuring my calibrated science images for submission to the AAVSO database I use VPhot. In addition, all elements for successful photometry are available from the AAVSO, including the Variable Star Plotter for maps of star fields including target and comp stars, and the Light Curve Generator which provides past and most recent observation data for a variable star. Photometry results from VPhot are exported in the AAVSO Extended Format allowing you to then load your results directly into the database.

IN CONCLUSION

For the amateur astronomer desiring to do more and explore the possibilities of citizen science, variable star photometry is certainly a field to investigate. If digital imaging is not your inroad, visual observing is still popular, with about half of AAVSO members exploring it prior to investing in more expensive equipment.

So why observe variable stars? Variation in the brightness of a star provides data without which many questions about stars would be impossible to answer. Remember that professional astronomers are unable to collect needed data from the thousands of constantly changing variables. Astronomers need the help of dedicated amateurs to gather this information; citizen scientists need to observe with a purpose.✶

MUSEUM OF THE SKY

CAN WE OBSERVE RELICS OF THE MILKY WAY'S CONSTRUCTION?

By Dave Tosteson

Great civilizations are buried under the sands of time. Babylon was inhabited for over four thousand years, once the largest city in the world with over 200,000 people. It was first noted as a small cultural and religious center in the Akkadian empire circa 2200 BCE, and last mentioned in the tenth century CE as "the small village of Babel." At the height of its glory, its significance was such that it contained two of the Seven Wonders of the World: its Hanging Gardens and the wondrous Ishtar Gate.

When my family was in Berlin before the turn of the millennium, we visited the Pergamon Museum, and their reproduction of the Ishtar Gate was breathtaking. Its deep blue color accented with gold and decorated friezes of mythic animals were meant to impress any visitor. A museum's power to take us back in time to visualize and experience bygone structures is unique. Recent advances in the ability to decipher clues to how the Milky Way formed and grew have given us a chance to do for it what archeologists have long done for ancient societies.

Scientists trying to determine the age of the Earth use the oldest available rocks for radiometric dating. Long lived isotopes such as those of uranium and thorium with half-lives on the order of one billion years have dated rocks in the Jack Hills region of Western Australia to 4.4 billion years old. But the surface of the Earth is being constantly eroded and affected by plate tectonics and subduction, so its actual age is almost certainly older than the oldest rocks we see. If the assumption is made that all bodies in the Solar System were formed at the same epoch, then dating its oldest material would be the most accurate indicator of Earth's age. Asteroids are debris left over from the formation of the planets and, fortunately, their small pieces rain down continuously onto Earth's surface. Through radiometric dating of their isotopes, Earth's age has been determined to be 4.567 billion years.

Using several methods, our galaxy's age can also be found using its oldest parts. Stellar ages are most accurately measured by carefully observing how their surfaces oscillate, which defines the relatively new field of asteroseismology. Convection in the outer layers of a star sets up standing waves within it, and the details of how these waves propagate and reflect reveal density changes deep inside it. The variances noted among stars are related to accumulation of heavier elements within them as they age. Coupling these data with theories of stellar evolution gives age estimates of 7 to 10 percent accuracy. The range of values presently given for the Milky Way's age is 13 to 13.6 billion years, meaning it began forming only a few hundred million years after the Big Bang (ABB), 13.8 billion years ago.

There is a magnitude-7.2 star in Libra called the "Methuselah Star" for its age of possibly over 13 billion years. It is one of our galaxy's oldest known stars, and is a G0 IV–V subgiant hypervelocity star approaching Earth. It has just 1/250th of the Sun's metallicity, or content of elements heavier than helium, a fact correlated to its extreme age. The Hubble Space Telescope was used to calculate its distance of 202 light-years, as it was close enough to use the parallax method. It is easily spotted in binoculars, and from a very dark site may be visible without optical aid.

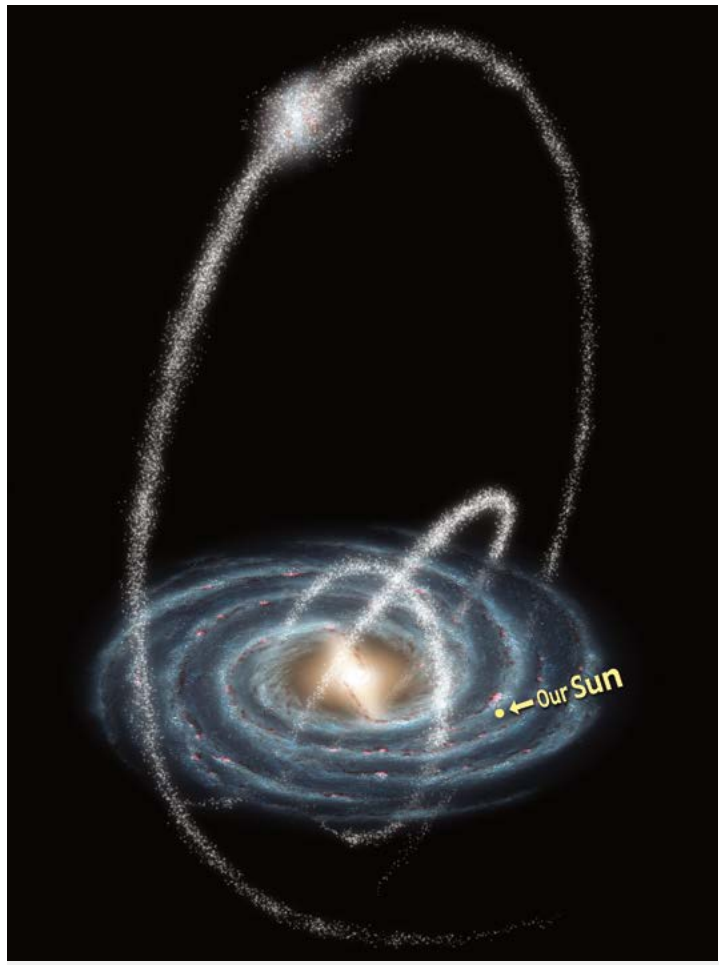
The James Webb Space Telescope (JWST) has been tasked with imaging and studying the earliest galaxies. A paper published in October 2022 by a large group headed by Jeyhan Kartaltepe of the Rochester Institute of Technology presented data on 850 early galaxies with redshifts between 3 and 9. Even their highest redshift galaxies, seen at only half a billion years ABB, had already established disks and spheroids. The conclusion of the authors was that further work was needed to "quantify when these features first formed." In November 2022, JWST data were published

Arp-40, colliding pair of galaxies. Image credit: NASA, ESA, and B. Holwerda (University of Louisville Research Foundation, Inc.); Image processing: G. Kober (NASA Goddard/Catholic University of America)

about a "remarkably luminous" galaxy at z=12.4, only 350 million years ABB. Galactic evolution models such as the FIRE (Feedback in Realistic Environments) computer simulation suggest galaxies grew rapidly in the early Universe, both by transfer of gas between nascent members and by merging with and accreting smaller pieces.

The Gaia satellite, launched in 2013, was designed to study up to two billion stars and accurately measure their positions and magnitudes. It is no overstatement to say it has revolutionized many fields of study. For galactic archeology, the topic of this article, its microarcsecond precision coupled with repeated measurements have allowed astronomers to categorize past and present stellar positions. Several previously suspected and new streams of stars from these data almost certainly represent captured dwarf galaxies from billions of years ago. The increasing number of identified streams is causing a complex categorization issue. A February 2022 paper from a group headed by Khyati Malhan of the Max Planck Institute presented a "Global Dynamical Atlas" of data from the early third release from Gaia (EDR3) to help keep the proliferating streams (41), satellite galaxies (46), and globular clusters (170) organized and accessible. New information can be incorporated within the atlas as it comes in.

Once the young Milky Way was recognizable, with a supermassive black hole in its core, a spheroidal bulge around it, and a disk that may or may not have had spiral structure, large additions of material such as the Sagittarius Dwarf Spheroidal Galaxy (Sag dSph) and Helmi doubled its size. Gaia's contributions to the field have allowed rapid progress in understanding this piecemeal evolution of the Milky Way.



When the Milky Way interacted with other galaxies such as Gaia Enceladus, our galaxy's gravity pulled stars out of them, forming streams of stars wrapped around and throughout the Milky Way. Image credit: NASA/JPL-Caltech/R. Hurt (SSC/Caltech).

The most significant event in our galaxy's growth was an encounter ten billion years ago with a dwarf one-fourth the Milky Way's size at the time. Galaxy mergers are divided into major and minor types, with the dividing line at the impacting galaxy having one-quarter of the primary's mass. For instance, Sag dSph had significantly less mass than this, and the future encounter with M31 in four billion years will be one between near equals. The importance of the distinction is that if the impactor is over the one-quarter figure, then the structural integrity of the primary galaxy will be jeopardized, as is seen in multiple glorious images from the Hubble Space Telescope (HST), particularly among Arp's peculiar systems. Computer simulations also bear this out, and most major mergers eventually create a relatively featureless elliptical galaxy without spiral structure or a recognizable disk.

Our borderline major merger ten billion years ago was with a large dwarf galaxy called Gaia Enceladus, or sometimes Gaia Sausage (GES) for its shape in velocity space. In Greek mythology, Enceladus was the giant son of Gaia buried beneath Mount Etna, where his hundred arms caused earthquakes, volcanoes, and general mayhem. The clues that GES was once an external galaxy include the pronounced ellipticity of its stellar paths, many of which orbit in a retrograde direction. The metal content of its stars is also decidedly higher than those of our home galaxy's halo. It added its fifty billion solar masses of stars and gas to the Milky Way, accounting for its largest addition until Andromeda drops by. The merger did not permanently disrupt our spiral structure, but several significant changes occurred. In a 2020 article called "Streams, substructures and the early history of the Milky Way," Amina Helmi (discoverer of the Helmi stream in 1999) discussed how our galaxy's thick disk was likely formed from the energy and new star formation from the merger with GES. The thick disk is about 7 to 10 thousand light-years wide (measured perpendicular to the plane of the galaxy), compared to the thin disk where almost all the gas and stellar formation occurs amid the spiral arms. This thin disk is only a thousand light-years wide, and our Sun resides within it.

Observational support for this accretion theory has been present since at least 1994, when Rodrigo Ibata and his colleagues imaged what is now called the Sagittarius Dwarf

Gaia Enceladus Red Giant Stars
(from Montalban)
"KIC" is Kepler Input Catalog.

KIC no.	RA (hms)	Dec (dms)	Mag (r)
2443903	19 26 17	37 45 53	11.8
2971380	19 05 12	38 06 29	12.5
3553435	19 34 40	38 40 52	12.9
3936507	19 01 53	39 00 08	12.3

Methuselah Star (HD 140283)
RA 15h 43m 03.1s **Dec**–10d 56m 00.1s.

NGC 2419
RA 07h 38m 09s **Dec** +36d 52m 55s **Mag** 9.1.

Whiting 1
RA 02h 02m 57s –03d 15m 10s **Mag** 15.0.

St Wr 2-21
RA 19h 14m 23.4s **Dec**–32d 34m 16.6s.

Spheroidal Galaxy. It was the first documented external galaxy seen to be merging with the Milky Way, and the globular cluster M54 appears to be its remnant core. Sag dSph has looped completely around the Milky Way several times, and its streams of stars were measured by the Gaia satellite. Its stars are generally older and lower in metal content compared to those of our galaxy. The original nine globular clusters that were captured as parts of it and incorporated into the Milky Way include NGC 2419 and Whiting 1, two of the most distant from the core of the Milky Way, at hundreds of thousands of light-years. This makes sense if they are looping in markedly elliptical orbits.

Milky Way globulars captured from the GES merger include M2, M56, M75, M79, NGC 2808, NGC 2298, and NGC 5286. I have spotted M2 naked eye in very good skies. NGC 2808 in Carina is the brightest of GES's clusters, and is thought to have been the core of Gaia Enceladus. I saw this magnitude-6.2 globular with binoculars from New Zealand in 2012. A 2021 study added eight more globulars in the near-infrared, upping GES's total to twenty-nine. This large number makes it a fairly globular-rich galaxy, but its original nine are the only clusters readily visible to amateurs. Studies have found several other dwarf galaxy mergers that contributed globulars to our galaxy's total. Eleven billion years ago, Kraken donated thirteen globulars. The Sagittarius Dwarf gave us seven, and the Helmi, Sequoia, and Pontus dwarfs gave us five, seven, and seven, respectively. I have even observed a planetary nebula from Sag dSph called St Wr 2-21, where one of its medium sized stars evolved off the main sequence. It seems logical that all types of stellar remains will eventually be found from captured dwarf galaxies, including neutron stars, supernova remnants, and black holes.

The Milky Way–GES merger likely did two other significant things. It replenished our thin disk with gas that increased star formation, and it created the "inner halo" through its infusion of angular momentum. In 2012, Jason Kalirai used white dwarf stars to estimate the age of this inner halo at 11 billion years. Gaia has identified several hundred thousand RR Lyrae stars in the Milky Way, many of them in the inner halo near us. RR Lyrae stars are older variable stars derived from lower mass progenitors, but are bright enough to be seen throughout our galaxy, and even beyond to the Local Group. Their period-luminosity relation allows moderately accurate distance estimates, particularly in the infrared. RR Lyrae itself is a 0.65-solar-mass object in western Lyra that varies between magnitudes 7.1 and 8.1. It is the brightest star of its class, and is easily visible in binoculars. It lies 850 light-years from us, and has not yet been identified with any accreted stellar component. More RR Lyrae data from GES will be available after their publication.

The positions of red giant stars on the Hertzsprung-Russell diagram as their cores heat up and start to fuse helium is relatively insensitive to their metallicity, but their H-R positions alone yield age estimates of only about 60 percent accuracy. Improved ages were needed to further the study of our galaxy's stellar archeology. The Kepler mission, launched in 2009, stared continuously at an area of the sky in the direction of Cygnus containing 500,000 stars. It produced high-quality spectra of physical oscillations (the asteroseismology discussed above) that greatly improved accuracy of their age estimates. Amateurs can readily observe many of Josefina Montalban's red giant stars attributed to GES, as they are 11th or 12th magnitude. Several of her group's ninety-five are in Table 1.

The miracle of museums is to gather relics from across time and space into a single place where, with elegant presentation, we can appreciate what experts have found. The next time you are at a clear dark site, take in the museum of the sky to consider the pieces and processes that have built our Milky Way galaxy. ✶

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IMPROVE YOUR DEEP-SKY SKETCHES

By Bill Castro

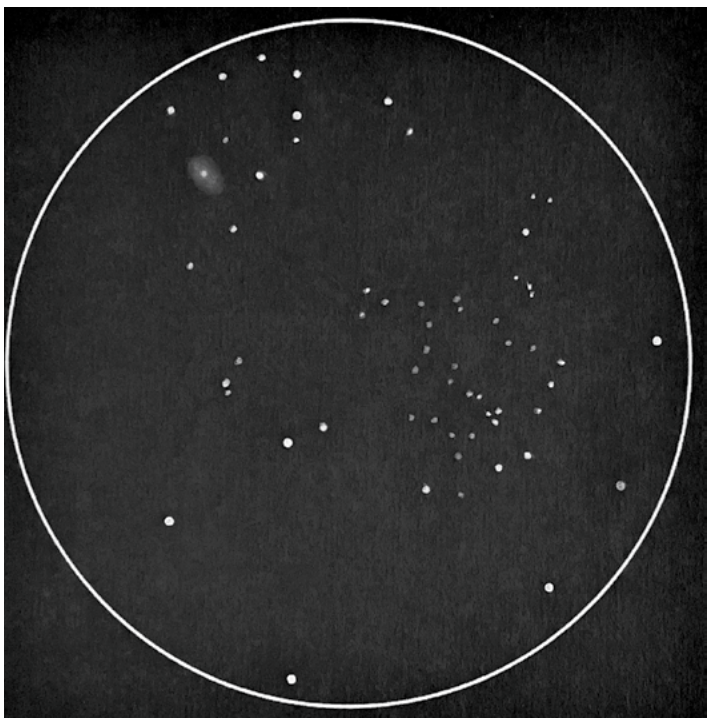
After completing the Sketching Observing Program a few years ago, I am still trying to improve my sketches. One thing other club members and I have been doing is to compare a sketch made at the eyepiece with a cellphone picture taken through the eyepiece. Newer cellphones can do a good job of taking a picture through the eyepiece. The picture is similar to what you saw and sketched. You don't get overwhelmed with stars and detail like you would with a long-exposure image that you would see online. The picture orientation (for example, the left-right swap of a refractor or the inverted image of a Newtonian) is the same as your sketch. A side-by-side comparison of the sketch with the picture during the light of day gives you good feedback on star positions and star brightnesses.

Here is an example that I shared at a recent club meeting. It shows Comet C/2022 E3 (ZTF) and open cluster NGC 1647 at 7:30 p.m. EST on February 13, 2023. The sketch (left) was made first at the eyepiece using graphite pencils on white paper. I used a Stellarvue SVX130T 130 mm f/7 apo refractor on a Celestron AVX mount. A 22 mm Nagler eyepiece gave a magnification of 41× and a 1.9-degree field of view. The sketch shown here was turned into a negative with Microsoft Paint and slightly enhanced. The comet and open cluster were less than a degree apart, an excellent view through the eyepiece. It was a joy to sit and gaze at these two objects in the same field of view. The comet was an asymmetrical fuzz but easily spotted. It had a very bright nucleus but never showed much of a tail in Oviedo, Florida, skies. The open cluster NGC 1647 has a half-moon shape with an even distribution of similar-magnitude stars.

The photo (right) was taken *after* the sketch, so as not to have light from the cellphone interfere with my night vision and lose the faint fuzzy details needed for the sketch. I used an iPhone 12 Pro handheld to the same eyepiece and equipment used for the sketch. The cellphone information states 4.2 mm, f/1.6, 1 second exposure at ISO 4000. The picture is cropped and slightly enhanced. There are a few more stars in the picture than what I saw visually in the eyepiece, but it's close.

It's interesting that the cellphone camera doesn't have as large a dynamic range as the human eye does. The comet didn't show up in the picture as well as it did by eye. The sketch is a better representation of what I saw at the eyepiece. The longer I looked through the eyepiece and sketched, the better it looked. I was happy with my star placement when comparing my sketch with the picture the next day. My star placement has improved after several iterations of sketch and picture comparisons. I should also note that this was done in my naked-eye limiting magnitude 4.0 backyard in the Orlando, Florida, suburbs. ✶

Bill Castro is a member of the Central Florida Astronomical Association



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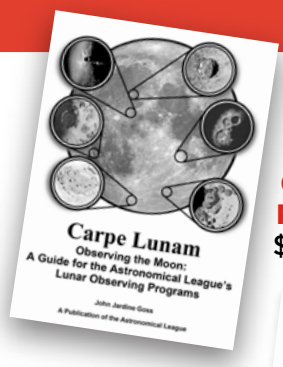

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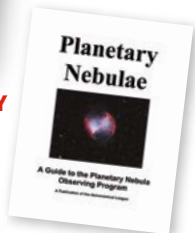

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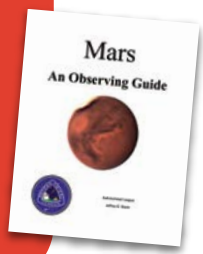

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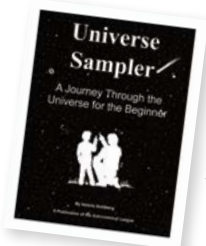

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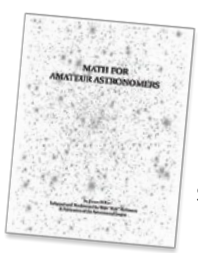

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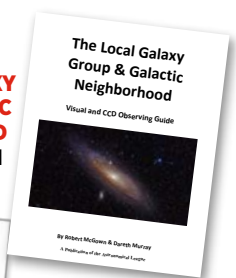

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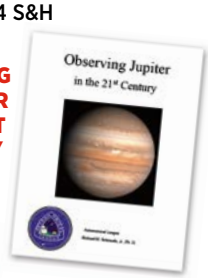

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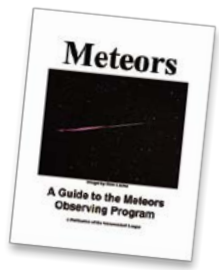

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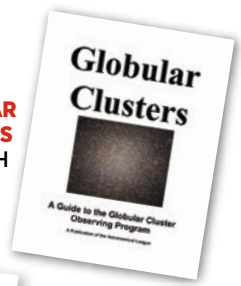

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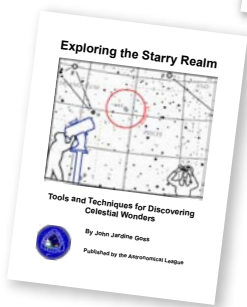

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GALLERY

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Top: Sam Pitts (Temecula Valley Astronomers) captured this image of M33 using a TMB 80mm refractor and a SBIG ST10XME CCD camera.

Below: Joe Ziha (Astronomical Society of Eastern Missouri) captured this image of IC 405 from his observatory in Animas, New Mexico, using a PlaneWave CDK14 with a ZWO ASI6200mm Pro camera.

Both images on this spread were rotated 90° clockwise from their original orientation.

This page: David Elmore (Longmont Astronomical Society) captured this deep, wide image of several molecular clouds in northern Cepheus using a Vixen VSD100 F/3.8 refractor and a ZWO ASI6200mm Pro CMOS camera

Next page: Bill Neubert (Astronomical Society of Eastern Missouri) captured this image of NGC 1333 from the Buford Mountain Conservation Area using a Boren-Simon Power-Newton Astrograph with 0.73× focal reducer/corrector and a QSI 683wsg-8 CCD camera.

Gallery images are processed by *Reflector* staff for better contrast and tonal range on the printed page.

Observing Awards

2022 Galaxy Challenge

Kathy Stewart, Bernard Astronomical Society

Active Galactic Nuclei Observing Program

No. 33, **Paul Runkle**, Chapel Hill Astronomical and Observational Society

Advanced Binocular Double Star Observing Program

No. 54, **William Loder**, Member-at-Large; No. 55, **Jeffrey Corder**, Ancient City Astronomy Club

Alternate Constellations Observing Program

No. 16, **Pete Hermes**, Silver, Tucson Amateur Astronomy Association

Arp Peculiar Galaxies Northern Observing Program

No. 115-I, **Mark Simonson**, Everett Astronomical Society; No. 116-I, **David Babb**, Member-at-Large; No. 117, **Mike Reitmajer**, Rose City Astronomers

Asterism Observing Program

No. 75, **Stephen J. Nugent**, Member-at-Large

Asteroid Observing Program

No. 68, **John T. Grage**, Regular, Member-at-Large; No. 69, **David Hasenauer**, Regular, Texas Astronomical Society of Dallas; No. 70, **Bernard Venasse**, Regular, Lifetime Member; No. 73, **Steve Boerner**, Gold, Member-at-Large

Beyond Polaris Observing Program

No. 62, **Richard Benson**, Rio Rancho Astronomical Society; No. 63, **Lindsey Benson**, Rio Rancho Astronomical Society; No. 64, **Joseph D. Kubal,** Naperville Astronomical Association; No. 65, **Cindy Krach**, Haleakala Amateur Astronomers

Binocular Double Star Observing Program

No. 206, **Craig Lamison**, Houston Astronomical Society; No. 207, **Elaine B. Osborne**, Echo Ridge Astronomical Society

Binocular Messier Observing Program

No. 1248, **John Barclay**, Tri-Valley Stargazers

Binocular Variable Star Observing Program

No. 62, **Pete Hermes**, Tucson Amateur Astronomy Association; No. 63, **Paul Runkle**, Chapel Hill Astronomical and Observational Society

Carbon Star Observing Program

No. 146-I, **Alan Sheidler**, Popular Astronomy Club; No. 147, **Bill Castro**, Central Florida Astronomical Society; No. 148, **Lisa Wentzel**, Twin City Amateur Astronomers; No. 149-I, **Daniel Beggs**, Albuquerque Astronomical Society; No. 150, **Gus Gomez**, Tucson Amateur Astronomy Association; No. 151, **Jeff Hoffmeister**, Olympic Astronomical Society

Citizen Science Special Program

Andrew Corkill, Lifetime Member, Observational, Variable Stars, Gold Class 2; **Dan Crowson**, Astronomical Society of Eastern Missouri, Active Asteroids, Active, Gold Class 40; **Dan Crowson**, Astronomical Society of Eastern Missouri, Supernova Hunters, Active, Gold Class 10; **Rich Krahling**, Richland Astronomical Society, Galaxy Zoo, Star Notes, Active, Gold Class 1; **Al Lamperti**, Delaware Valley Amateur Astronomers, Galaxy Zoo, Star Notes, Active, Gold Class 197; **Al Lamperti**, Delaware Valley Amateur Astronomers, Active Asteroids, Active, Gold Class 96; **W. Maynard Pittendreigh**, Lifetime Member, Are We Alone in the Universe, Active, Bronze; **Brad Young**, Astronomy Club of Tulsa, Variable Stars, Observational, Gold Class 6

Comet Observing Program

No. 60, **David Roemer**, Gold, Huachuca Astronomy Club; No. 61, **Rob Ratkowski**, Gold, Haleakala Amateur Astronomers; No. 130, **David Hasenauer**, Silver, Texas Astronomical Society of Dallas; No. 131, **Curron Donnie Hill**, Silver, Crystal Coast Stargazers; No. 132, **Jim Rasmussen**, Silver, Denver Astronomical Society

Constellation Hunter Northern Skies Observing Program

No. 297, **Jerelyn Ramirez**, Kansas Astronomical Observers; No. 298, **Matt Harbison**, Barnard Astronomical Society; No. 299, **Larry Bloom**, Longmont Astronomical Society; No. 300, **Tom Sturik**, Echo Ridge Astronomical Society

Dark Nebula Observing Program

Nos. 39 and 39i, **Brad Payne**, Northern Virginia Astronomy Club

Double Star Observing Program

No. 700, **John Henry Barnett,** Richmond Astronomical Society; No. 701, **Robert Winterstein,** Member-at-Large; No. 702, **Pete Hermes,** Tucson Amateur Astronomy Association; No. 703, **Anas Sawallha,** Member-at-Large; No. 704, **Kyle Penning,** Ancient City Astronomy Club

Flat Galaxy Observing Program

No. 45, **Mark L. Mitchell**, Honorary, Delaware Astronomical Society

Foundations of Imaging Observing Program

No. 9, **Jeffrey Corder**, Ancient City Astronomy Club

Globular Cluster Challenge

Laurie V. Ansorge, Lifetime Member; **Steve Boerner**, Member-at-Large; **Brett Boller**, Prairie Astronomy Club; **Richard Clements**, Barnard Astronomical Society; **Aaron Clevenson**, North Houston Astronomy Club; **Dan Crowson**, Astronomical Society of Eastern Missouri; **David Dickinson**, Prairie Astronomy Club; **Tony Edwards**, Island County Astronomical Society; **David Ernst**, Minnesota Astronomical Society; **Katelyn Farneth**, Prairie Astronomy Club; **Pete Hermes**, Tucson Amateur Astronomy Association; **Bob Kacvinsky**, Prairie Astronomy Club; **John McClaren**, Seattle Astronomical Society; **Ralph McConnell**, Barnard Astronomical Society; **Bill Okerlund**, Houston Astronomical Society; **Rick Palmer**, Buffalo Astronomical Association; **Brad Payne**, Northern Virginia Astronomy Club; **Russell F. Pinizzotto**, Southern Maine Astronomers; **W. Maynard Pittendreigh**, Lifetime Member; **Rick Ray**, North Houston Astronomy Club; **Mae Rusconi**, Independent; **Rahul Sangole**, Member-at-Large; **Mark Simonson**, Everett Astronomical Society; **Kathy Stewart**, Barnard Astronomical Society; **Jeff Wilson**, Rose City Astronomers; **David Wood**, Astronomical Society of Eastern Missouri; **Brad Young**, Astronomy Club of Tulsa

Globular Cluster Observing Program

No. 393, **Conal Richards**, Lifetime Member; No. 394, **Clariza E. Kern**, Pontchartrain Astronomy Society; No. 395, **Paul Runkle**, Chapel Hill Astronomical and Observational Society

Herschel Society

Steve Boerner, Silver, Member-at-Large; **David Hasenauer**, Silver, Texas Astronomical Society – Dallas

Herschel II Observing Program

No. 119, **Steve Boerner**, Member-at-Large; No. 120, **Brad Payne**, Manual, Northern Virginia Astronomy Club

Hydrogen Alpha Solar Observing Program

No. 71, **Viola Sanchez**, Albuquerque Astronomical Society; No. 72-I, **Brad Payne**, Northern Virginia Astronomy Club; No. 73, **Matthew T. Russell**, Colorado Springs Astronomical Society

Library Telescope Program

No. 30, **Randy Harrison**, Silver, River Bend Astronomy Club; No. 31, **Mike Modrcin**, Silver, Omaha Astronomical Society; No. 32, **Robert Scott**, Silver and Gold, Island County Astronomical Society

Local Galaxy Group and Neighborhood Observing Program

No. 56-M, **Paul Runkle**, Chapel Hill Astronomical and Observational Society; No. 57-I, **Terry N. Trees**, Amateur Astronomers Association of Pittsburgh

Lunar Evolution Observing Program

No. 28, **Bernard Venasse**, Lifetime Member

Lunar Observing Program

No. 1199, **William Clarke**, Tucson Amateur Astronomy Association; Nos. 1200 and 1200-B, **Kasey Davis**, Pocatello Astronomical Society; No. 1201-B, **Jeremy Mullican**, Lifetime Member; Nos. 1202 and 1202-B, **Richard Benson**, Rio Rancho Astronomical Society; No. 1203-B, **Krista Lemoine**, Baton Rouge Astronomical Society; Nos. 1204 and 1204-B, **Kim Riggs**, Colorado Springs Astronomical Society; Nos. 1205 and 1205-B, **Matthew T. Russell**, Colorado Springs Astronomical Society; Nos. 1206 and 1206-B, **Ralph McConnell**, Barnard Astronomical Society

Lunar II Observing Program

No. 114-I, **Brad Payne**, Northern Virginia Astronomy Club; No. 134-I**, Anis Sawallha**, Member-at-Large; No. 135-I, **Daniel Beggs**, Albuquerque Astronomical Society; No. 136**, Albert Smith**, Member-at-Large; No. 137, **Marie Lott**, Atlanta Astronomy Club

Mentor Award

Chuck Cummins, Northeast Florida Astronomical Society; **Ted Treiber**, Northeast Florida Astronomical Society

Messier Observing Program

No. 2802, **Don Knabb**, Honorary, Chester County Astronomical Society; No. 2901, **Conal Richards**, Honorary, Lifetime Member; No. 2902, **Robert Winterstein**, Honorary, Member-at-Large; No. 2903, **Jason Wallace**, Honorary, Richland Astronomical Society; No. 2904, **Mark Ellison**, Regular, Member-at-Large

Meteor Observing Program

No. 78, **Gregory T. Shanos**, Honorary, Museum Astronomical Resource Society

Open Clusters Observing Program

No. 111-I, **Daniel Beggs**, Advanced Imaging, Albuquerque Astronomical Society; No. 114-I, **Russell F. Pinizzotto**, Advanced, Southern Maine Astronomers; No. 115, **Cindy Krach**, Advanced, Haleakala Amateur Astronomers; No. 116, **Karl A. Schultz**, Advanced, Central Arkansas Astronomical Society; No. 117, **Jonathan A. Cross**, Advanced, Seattle Astronomical Society; No. 118-I, **Marie Lott**, Advanced Imaging, Atlanta Astronomy Club

Outreach Program

No. 353, **Susan Pollard**, Master, North Houston Astronomy Club; No. 505, **Rusty Hill**, Master, North Houston Astronomy Club; No. 1027, **Teresa Bippert-Plymate**, Master, Big Bear Valley Astronomical Society; No. 1070, **Sonny Manley**, Master, Fort Bend Astronomy Club; No. 1179, **David Dutschmann**, Master, North Houston Astronomy Club; No. 1181, **Benjamin Dutschmann**, Master, North Houston Astronomy Club; No. 1234, **Trena Johnson**, Stellar, Minnesota Astronomical Society; No. 1254, **David R. Catlin**, Stellar, Boise Astronomical Society; No. 1323, **Terry Menz**, Stellar, Master, River Bend Astronomy Club; No. 1324, **Jeff Menz**, Stellar, Master, River Bend Astronomy Club; No. 1326, **Trevor Arnold**, Outreach, North Houston Astronomy Club; No. 1327, **Jeff Barney**, Outreach, North Houston Astronomy Club; No. 1328, **Sol Bobst**, Outreach, North Houston Astronomy Club; No. 1329, **Tom Conley**, Outreach, North Houston Astronomy Club; No. 1330, **Leanna Fregia**, Outreach, North Houston Astronomy Club; No. 1331, **Chris Jones**, Outreach, North Houston Astronomy Club; No. 1332, **Terry Jones**, Outreach, North Houston Astronomy Club; No. 1333, **Icelynn Lacking**, Outreach, North Houston Astronomy Club; No. 1334, **Bhavia Madan**, Outreach, North Houston Astronomy Club; No. 1335, **Jigisha Madan**, Outreach, North Houston Astronomy Club; No. 1336, **Barbara Madera**, Outreach, North Houston Astronomy Club; No. 1337, **Anthony Murphy**, Outreach, North Houston Astronomy Club; No. 1338, **Justin McCollum**, Outreach, North Houston Astronomy Club; No. 1339, **Frank Nowatzke**, Outreach, North Houston Astronomy Club; No. 1340, **Aissa Chai**, Outreach, Rose City Astronomers; No. 1341, **Dan Brandon**, Outreach, Stellar, River Bend Astronomy Club; No. 1342, **Kerry Brethauer**, Outreach, River Bend Astronomy Club; No. 1343, **Cheryl Brinkman**, Outreach, River Bend Astronomy Club; No. 1344, **Spencer Chapman**, Outreach, River Bend Astronomy Club; No. 1345, **Richard Dietz**, Outreach, River Bend Astronomy Club; No. 1346, **Karen Fajardo**, Outreach, River Bend Astronomy Club; No. 1347, **Randy Harrison**, Outreach, Stellar, River Bend Astronomy Club; No. 1348, **Dave Kirsch**, Outreach, Stellar, River Bend Astronomy Club; No. 1349, **Lance Taylor**, Outreach, River Bend Astronomy Club; No. 1350, **Jim Reagan**, Outreach, Stellar, River Bend Astronomy Club; No. 1351, **Brandon Runyon**, Outreach, River Bend Astronomy Club; No. 1352, **Chris Weis**, Outreach, River Bend Astronomy Club; No. 1353, **James D. Anderson**, Outreach, Astronomical Society of Kansas City; No. 1354, **Rolando Gamino**, Outreach, Popular Astronomy Club; No. 1355, **Eva Davison**, Outreach, Popular Astronomy Club; No. 1356, **Angele Mott Nickerson**, Outreach, Rose City Astronomers; No. 1357, **John Strebeck**, Outreach, St. Louis Astronomical Society; No. 1358, **Kathleen Strebeck,** Outreach, St. Louis Astronomical Society; No. 1359, **Christian Jones**, Outreach, Cincinnati Astronomical Society; No. 1360, **Daniel Beggs**, Outreach, Albuquerque Astronomical Society; No. 1361, **John Jezak**, Outreach, Astronomical Society of Kansas City; No. 1362, **Allison Bair**, Outreach, Omaha Astronomical Society; No. 1363, **Jon Larsen**, Outreach, Omaha Astronomical Society; No. 1364, **B.J. Austin**, Outreach, Stellar, Master, Wabash Valley Astronomical Society; No. 1365, **Anonymous**, Outreach, Wabash Valley Astronomical Society; No. 1366, **Andrew Schilling**, Outreach, Stellar, Master, Wabash Valley Astronomical Society; No. 1367, **Edmund Harfmann**, Outreach, Stellar, Master, Wabash Valley Astronomical Society; No. 1368, **Emmaline Terlep**, Outreach, Wabash Valley Astronomical Society; No. 1369, **Lisa Wieland**, Outreach, Stellar, Master, Wabash Valley Astronomical Society; No. 1370, **George Wyncott**, Outreach, Stellar, Master, Wabash Valley Astronomical Society; No. 1371, **Vince A. Sempronio**, Outreach, Stellar, Huachuca Astronomy Club; No. 1372, **Craig Lamison**, Outreach, Houston Astronomical Society; No. 1373, **Alan Bott**, Outreach, Northeast Florida Astronomical Society

Planetary Nebula Observing Program

No. 103, **Scott Cadwallader**, Advanced, Baton Rouge Astronomical Society; No. 104, **Mike Reitmajer**, Advanced, Manual, Rose City Astronomers

Radio Astronomy Observing Program

No. 16, **Mark Simonson**, Gold, Everett Astronomical Society

Sketching Program

No. 60, **Jeffrey S. Moorhouse**, La Crosse Area Astronomical Society

Solar System Moons Challenge

Steve Boerner, Member-at-Large; **Scott Cadwallader**, Baton Rouge Astronomical Society; **Aaron Clevenson**, North Houston Astronomy Club; **Brad Young**, Astronomy Club of Tulsa

Solar Neighborhood Observing Program

No. 8, **Stephen Nugent**, Binocular, Member-at-Large; No. 9, **Lisa Wentzel**, Binocular, Twin City Amateur Astronomers

Solar System Observing Program

No. 207, **Tom Nelson**, Tucson Amateur Astronomy Association; No. 208, **Ryan Behrends**, Hill Country Astronomers; No. 209-I, **J. Robert Kirkham**, Member-at-Large; No. 210-I, **Brad Payne**, Northern Virginia Astronomy Club; No. 211-B, **William Clarke**, Tucson Amateur Astronomy Association; No. 212, **Larry Bloom**, Longmont Astronomical Society; Nos. 213 and 213-B, **Pete Hermes**, Tucson Amateur Astronomy Association

Southern Sky Binocular Observing Program

No. 106, **Lisa Wentzel**, Twin City Amateur Astronomers

Southern Sky Telescopic Observing Program

No. 64, **W. Maynard Pittendreigh**, Lifetime Member; No. 65, **Eric Edwards**, Albuquerque Astronomical Society

Sunspotter Observing Program

No. 222, **John Lilly**, Boise Astronomical Society; No. 223, **Glynn Germany**, Rio Rancho Astronomical Society; No. 224, **Viola Sanchez**, Albuquerque Astronomical Society; No. 225, **Jeffrey S. Moorhouse**, La Crosse Area Astronomical Society; No. 226, **Paul Runkle**, Chapel Hill Astronomical and Observational Society; No. 227-I, **Daniel Beggs**, Albuquerque Astronomical Society; No. 228-I, **István Mátis**, Member-at-Large

Two in the View Observing Program

No. 56, **Mark Simonson**, Everett Astronomical Society; No. 57, **Steve Boerner**, Member-at-Large; No. 58, **Carl J. Wenning,** Twin City Amateur Astronomers

Urban Observing Program

No. 237, **Glynn Germany**, Rio Rancho Astronomical Society; No. 238, **Michael Bond**, Northern Virginia Astronomy Club

Variable Star Observing Program

No. 57, **Brook Belay**, Atlanta Astronomy Club

Master Observer Progression

OBSERVER AWARD

J. Robert Kirkham, Member-at-Large; **Russell F. Pinizzotto**, Southern Maine Astronomers

MASTER OBSERVER AWARD

No. 257, **Jeffrey S. Moorhouse**, La Crosse Area Astronomical Society; No. 258, **Russell F. Pinizzotto**, Southern Maine Astronomers; No. 259, **Mike Reitmajer**, Rose City Astronomers

BINOCULAR MASTER AWARD

William Clarke, Tucson Amateur Astronomy Association; **Stephen J. Nugent**; Member-at-Large; **Brad Payne**, Northern Virginia Astronomy Club; **Russell F. Pinizzotto**, Southern Maine Astronomers; **Lisa Wentzel**, Twin City Amateur Astronomers

MASTER IMAGER AWARD

Mark Simonson, Everett Astronomical Society

ADVANCED OBSERVER AWARD

Daniel Beggs, Albuquerque Astronomical Society

MASTER OBSERVER AWARD – SILVER

Cindy Krach, Haleakala Amateur Astronomers; **Viola Sanchez**, Albuquerque Astronomical Society

MASTER OBSERVER AWARD – PLATINUM

Mark Simonson, Everett Astronomical Society

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