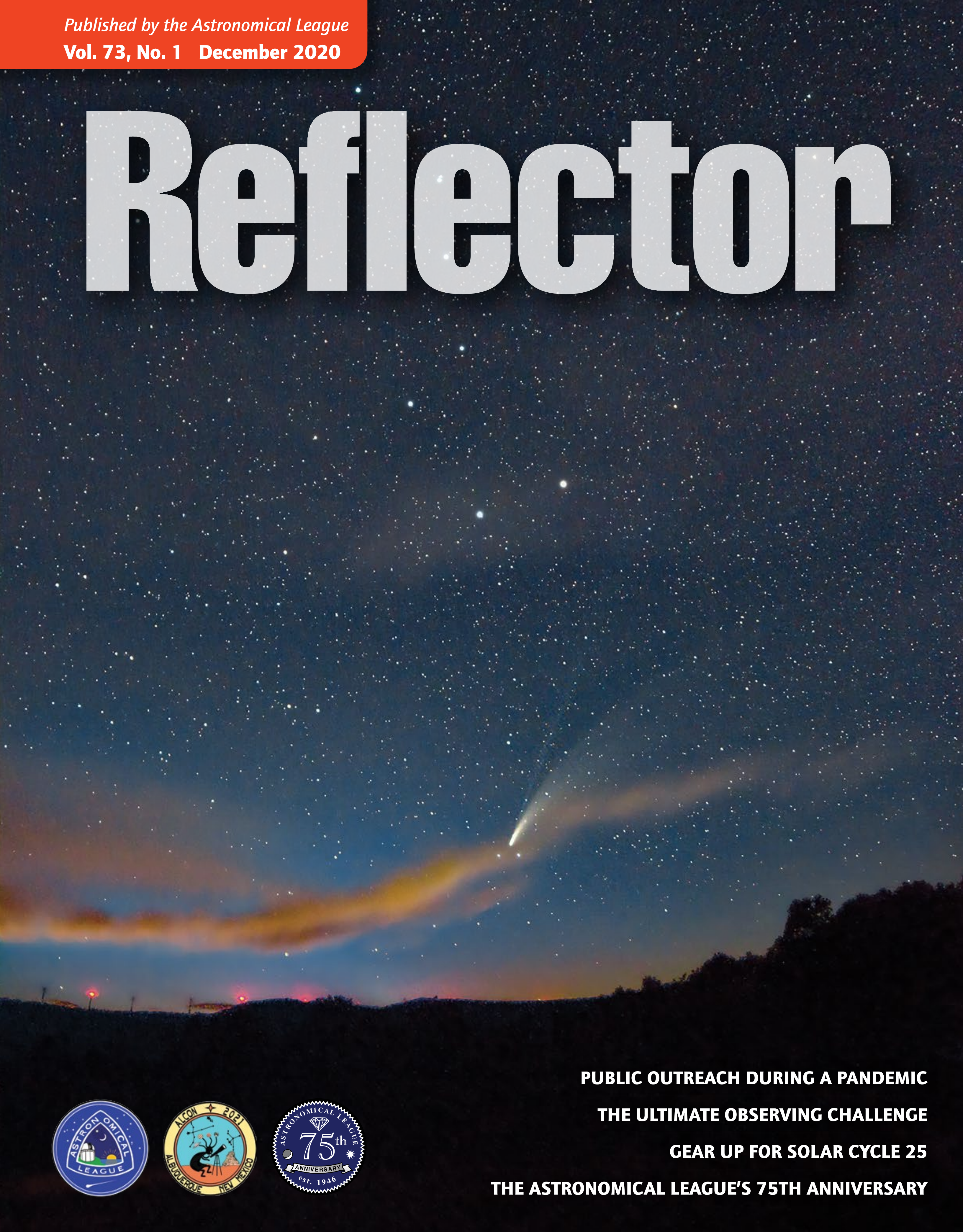
Published by the Astronomical League
Vol. 73, No. 1 December 2020

Reflector



PUBLIC OUTREACH DURING A PANDEMIC

THE ULTIMATE OBSERVING CHALLENGE

GEAR UP FOR SOLAR CYCLE 25

THE ASTRONOMICAL LEAGUE'S 75TH ANNIVERSARY

Contents

PAGE 16

PAGE 12

PAGE 23

Michael Rosolina and J. Perez (Greenbrier Valley Astronomy Association) captured this image of Comet C/2020 F3 (NEOWISE) on the evening of July 18 from Friars Hill, West Virginia, using a Canon T5i with a 14 mm lens.

Reflector

The Astronomical League Magazine
Vol. 73, No. 1 • ISSN: 0034-2963 • DECEMBER 2020

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.

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

BRINGING ASTRONOMY TO THE PEOPLE
ASTRONOMY DAY
MAY 15 & OCTOBER 9 2021
DEADLINE to enter Astronomy Day Award June 13, 2021
For entry forms:
www.astroleague.org
click on "Astronomy Day"
scroll down to "Astronomy Day Award Application"
For additional information, contact Gary Tomlinson Astronomy Day Coordinator gtomlins@sbcglobal.net

Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

Issued by the Astronomical League in March, June, September, and December, *Reflector* (ISSN: 0034-2963) is sent directly, either by postal mail or via a digital link, to each individual member of its affiliate societies and to members-at-large as a benefit of League membership. Individual copies of *Reflector* are available at the following subscription rates, payable to the League's national office.

PAPER SUBSCRIPTIONS:

USA & possessions: $3.00 each or $10.00 per year (4 issues)
Canada: $5.00 each or $16.00 per year
Mexico: $6.00 each or $22.00 per year
Other countries: $7.00 each or $25.00 per year

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**

NATIONAL OFFICERS

President
Carroll Iorg
9201 Ward Parkway, Suite 100 • Kansas City, MO 64114;
816-444-4878 • *president@astroleague.org*

Vice President
Chuck Allen
4005 St. Germaine Court., Louisville, KY 40207
502-693-5504 • *vicepresident@astroleague.org*

Secretary
Terry Mann
P.O. Box 211
West Manchester, Ohio 45382

Treasurer
Bill Dillon
190 Settlers Road • Fincastle, VA 24090
703-674-8484 • *treasurer@astroleague.org*

Executive Secretary
Maynard Pittendreigh
3208 Little Oak Way • Orlando, FL 32812
770-237-2071 • *executivesecretary@astroleague.org*

National Office
Mike Stoakes, Office Coordinator
Astronomical League National Headquarters
9201 Ward Parkway, Suite 100 • Kansas City, MO 64114
816-DEEP-SKY
National office: *leagueoffice@astroleague.org*
Society rosters: *rosters@astroleague.org*
League sales: *leaguesales@astroleague.org*

National Observing Program Directors

Cliff Mygatt
cliffandchris@wavecable.com

Aaron B. Clevenson
aaron@clevenson.org

Al Lamperti
lamperti@temple.edu

Maynard Pittendreigh
maynard@pittendreigh.net

Astronomical League Historian
Mike Stewart 913-240-1238 • *AL_Historian@kc.rr.com*

LETTERS TO THE EDITOR

Send to *editor@astroleague.org* with subject line "letter to editor"

***REFLECTOR* STAFF**

Managing Editor
Ron Kramer
Mobile: 520-500-7295
managingeditor@astroleague.org

Editor
Kristine Larsen
larsen@ccsu.edu

Assistant Editor
Kevin Jones
j11.kevin@gmail.com

Photo Editor
Dan Crowson
photoeditor@astroleague.org

Design/Production
Michael Patterson
michael.patterson@stellafane.org

Advertising Representative
Carla Johns
970-567-8878
advertising@astroleague.org

Coming Events Editor
John Wagoner
astrowagon@verizon.net

To the Editor:

It is always a pleasure for this astronomer-turned-historian of science to read colleagues' views on our mutual subject! I have a couple of thoughts, however, to share with author Dave Tosteson and your readers.

First, about Shapley: he did indeed defend the view that one big Milky Way galaxy was the universe at the 1920 Curtis-Shapley debate, but his immediate reaction to Hubble's discovery, which Hubble informed him of in a private letter before publication, was that there were actually other galaxies (though if they were "island universes" then ours was a continent). He expressed this to Cecilia Helena Payne (later Gaposchkin) as "this is the letter that destroyed my universe."

Second, about the process that drives Cepheid pulsation: indeed it is the ionization of He II (with one electron) to He III (with no electrons), but the other way around. He II is in the lower atmosphere and readily absorbs lots of light (of ultraviolet wavelengths with enough energy to ionize away that second electron), trapping the light until the He II is all He III. Then, as the light streams out, the star brightens, until the reservoir is empty, gas falls back, recombines with the electrons back to He II, and starts absorbing again. This keeps up until the processes of stellar evolution move the star out of that instability strip where He II is at the right depth in the atmosphere to do the trick. He III is quite transparent, with only electron scattering to contribute to the opacity (designated by the Greek letter kappa).

Incidentally, Sir Arthur Eddington worked hard on this kappa mechanism, but thought it was the ionization of hydrogen that did the trick.

RR Lyrae stars indeed also live in the instability strip, but belong on the horizontal branch of evolutionary sequence.

—Virginia Trimble
Professor of Physics and Astronomy, University of California, Irvine; President of Commission G-1, Binary and Multiple Stars, of the International Astronomical Union

DID YOU KNOW...

Sci Fi/Fantasy writer C.S. Lewis included a fairly accurate description of a dying red giant star in his 1955 novel *The Magician's Nephew.* His inspiration was possibly astronomer Fred Hoyle's famous 1950 series of BBC radio broadcasts and the related book *The Nature of the Universe.*

Star Beams

FROM THE PRESIDENT

NEW LEAGUE SECRETARY

I am pleased to announce the appointment of Terry Mann as the new secretary of the League, filling the balance of vice president Chuck Allen's term as secretary. Terry has served many past roles with the League, including president. Welcome back, Terry!

WEBSITE HELP NEEDED

We are in need of help from members who are proficient with WordPress. If you can lend some time and expertise in helping us keep our website fresh and current, please email me at *president@astroleague.org.*

THE STATE OF OUR ASTRONOMICAL FAMILY AS WE MOVE THROUGH THE COVID-19 PANDEMIC

What changes the pandemic has brought this year! Although our outreach activities, meetings, etc. have been sharply curtailed, many good new practices have come out of this. The League leadership, as well as countless societies around the country, have used online technology to transact business from home. Speakers from the United States and the rest of the world are more accessible with Zoom and other similar software. In addition, many clubs have conducted online public programs for their local communities. Other groups have shared live images online from their own or other observatory telescopes.

Once this pandemic passes, it appears that there will be pent-up interest in astronomy. Our reports indicate that sales of telescopes and related equipment continue to be strong during this time.

ALCON 2021

ALCon 2021, the national convention of the Astronomical League, is scheduled for August 5–7 in Albuquerque. Chair Jim Fordice and the committee have an outstanding lineup of speakers and activities for the event.

ALCon Jr., the youth portion of ALCon, is planning such activities as assembling their own telescopes and generally just having a good time learning more about astronomy.

Registration is scheduled to open around January 1, 2021.

In closing, stay safe, and live one day at a time as we continue moving through these very different times that can also be times of opportunity.

—Carroll Iorg, President

International Dark-Sky Association

NO LIGHT SWITCH

I do not know how many times I have been to a star party where there is an obtrusive light that no one knows how to turn off. Nobody knows where the light switch is located or has access to the switch. At star parties on the grounds of the Flandrau Science Center at the University of Arizona, the lights around the building are lit all night long. Either no one knows how to turn off the lights or has access to the switches or, even worse, there is no *off* switch. The lights simply come on at night triggered by their photocells or a remote timer.

This is a frustrating experience and sometimes shows lack of preparation by the star party planners; more often it highlights the poor design of the annoying lighting systems. I am writing this column during the COVID-19 pandemic, making it hard to imagine star parties and amateur astronomy meetings being live with person-to-person interactions. When we finally get back to that stage, hopefully sooner rather than later, I would urge those planning star parties to think ahead and make sure any annoying nearby lights can be turned off, dimmed, or at least adequately blocked. This is, of course, easy to say and very often hard to do.

On a personal note, I recently encountered a neighborhood situation that may well be common around the country. My stepdaughter Donna, her husband Sunil, and two young grandchildren moved into a gorgeous, brand-new house built on the lot next to our lot. My wife Carol and I had given that lot to Donna and Sunil, and we are happy they are nearby. Their house is only partially visible from our house, but one night I noticed their very bright porch and garage lights.

At the final inspection of Donna and Sunil's house prior to legal occupancy, the county building inspector approved the house for occupancy but noted in passing that the porch lights and the garage lights do not meet the county light pollution ordinance as they are unshielded. The light fixtures look like those found on a typical horse-drawn coach from yesteryear. There is beautiful brass lattice grill work. Unfortunately, the bulb hangs vertically and is minimally shielded by the open lattice design. Donna chose the lights for how nice the luminaires looked during the day, not considering how well they functioned at night. The builder did not bother to point out to her such a fixture was illegal in Pima County, Arizona, and the county building inspector was not bothered enough by it to require a fixture change. Egad!

But, not to worry, the porch lights and garage lights do not really need to be on at all. The driveway and walkway to the house are well demarcated after dark with low-lumen, shielded solar luminaires. I told Donna and Sunil I was somewhat aghast at their choice of lights, but they could simply leave them off most of the time. They then told me there was no way to turn off the lights at night. They simply came on, controlled by a photocell. That was the way the house was designed. The builder told them these lights had to be on all night because of a county rule. Yikes! As you might imagine, I was not at all amused.

Sunil gave me the phone number for the owner of the company that built their house. For the sake of this vignette, let's call him "Bob"; he politely took my call. I told him quite honestly his company did a wonderful job on the house and lot preparation. It is probably the nicest house in the neighborhood, but I was very concerned about the porch and garage lights.

Bob initially told me house address numbers had to be readily visible for 911 nighttime calls to the house by police, fire, or ambulance. His houses are mainly designed such that one or more of the porch or garage lights shine on the house numbers, making them easily visible from the street. Most houses he builds are not set back far from the street. Bob then thought about it more and laughed. It turns out all houses must have identifiable address numbers for police and fire. This can be done in many ways: a mailbox with large address numbers, a curb with house numbers in reflective paint, a large reflective mural on the side of the house, or address numbers on the front porch near a light that can be turned on when someone is awaiting a 911 call. None of this mandates all-night lighting.

Bob typically builds smaller tract homes while Donna and Sunil's house was more of a custom job, modifying one of his standard designs for their needs and budget. The proprietary electrical design for Bob's houses assumes porch and outside garage lights will be on all night with one of the lights shining on the house address number on the side of the house, typically by the porch or garage.

Bob said Donna and Sunil's house was 250 feet up a small hill from the street and had a well-labeled mailbox that he had installed at the street entrance to their driveway. There was no need for their outdoor lights to be on all night, and, in fact, the street numbers on the house could not even be seen from the street. Bob agreed to install a switch for the porch and garage outside lights, which has been done, and he further agreed to modify all his house designs so no light inside or outside is installed without a way for it to be turned off. He thanked me for pointing out this design issue. This conversation further convinced me that Donna and Sunil had chosen a first-class builder for their new house.

This story had a happy ending, but it illustrates, unfortunately, how little thought goes into the design for outdoor nighttime lighting. No doubt there are thousands of porch and outdoor garage lights burning through the night for no other reason than no one knows how to turn them off. Rats! Double rats! Triple rats! If you encounter a similar situation, I hope you can track down the problem far enough to effect a solution and get an unneeded light turned off.

—Tim Hunter
Co-founder, IDA
ida@darksky.org

Night Sky Network

THE BIG ASTRONOMY TOOLKIT

The Big Astronomy Toolkit was released to Night Sky Network member clubs this fall. Drawing its inspiration from the thousands of individuals who work together to make possible the scientific discovery performed at giant modern observatories, this new toolkit's theme is that astronomy is for everyone. We wanted to share behind-the-scenes knowledge of how the NSN's outreach resources are developed, so we thought it would be fun to do so as an interview between NSN admins Dave Prosper (in New York State) and Vivian White (in California):

Dave: This is an exciting release for the NSN program! What topics does the Big Astronomy Outreach Toolkit cover?

Vivian: This toolkit covers an array of topics that support the *Big Astronomy* planetarium show. The themes of the activities are dark skies, cultural astronomy, multiwavelength astronomy, and the notion that astronomy is open to everyone.

Dave: Do you have any favorite activities in this kit?

Vivian: We adapted one of my favorite activities from the Quality Lighting Teaching Kit (*bit.ly/qualitylightingkit*) on shielding lights for better safety and to reduce glare. It's such a simple, powerful demonstration that engages adults and

This banner highlights a few of the amazing folks who work together to bring "Big Astronomy" down to Earth. It's just one of the new materials available in the latest NSN Outreach Toolkit!

children alike. I'm also fond of the "Astronomy: Space for Everyone" banner that shows diverse people doing different work to bring the wonder of the Universe to us Earthlings.

Dave: What was the inspiration for the Big Astronomy Toolkit? Why did it come about?

Vivian: In 2015, I was part of the very first cohort of educators to travel from the U.S. down to Chile as part of the Astronomy in Chile Educator Ambassadors Program (ACEAP). We were introduced to the incredible astronomical facilities and people working in cutting-edge astronomy. We became fast friends with a shared passion for the skies of the Southern Hemisphere, and continued to work together on projects when we returned. We are teachers, planetarians, and informal educators, so our different spheres intersected on many projects, from exoplanet naming to eclipses! We wanted to share the rare beauty of the Chilean landscape and people and submitted two ideas to NSF for funding. We were thrilled that they liked this one!

Dave: Who are the folks heading up the Big Astronomy project?

Vivian: The Big Astronomy project was submitted as "Dome+," with the "+" meaning that we are testing how adding additional activities to the planetarium show will increase community participation. The planetarium show was produced by the California Academy of Sciences in both English and Spanish. The Ward Beecher Planetarium distributes the show and maintains a web portal at *bigastronomy.org.* In addition, friends at the Peoria Riverfront Museum are hosting live online events over the next two years, and the Abrams Planetarium is researching how all of these pieces work together. Tim Spuck at AUI is the principal investigator for the whole project, herding us cats to keep it rolling.

Dave: When did the work on the Big Astronomy Toolkit start? How long does it normally take to create a kit for the Night Sky Network, and did the pandemic disrupt that timeline at all?

Vivian: We started this project in 2018 and the planetarium show was scheduled to debut in May of 2020. As you can imagine, that wasn't a great time for live planetarium shows. The release was pushed back to September 26, with most of the premiere occurring online but some planetariums open with limited seating. This show is available free or low-cost to planetariums worldwide and there are different restrictions on gatherings depending on location. It has already been translated into at least five languages and many more are in the works!

Dave: Who helped with creating these kits?

Vivian: The Astronomical Society of the Pacific is an incredible place to work, even when we can't physically get to the office. Coordinating and assembling 300 toolkits while social distancing was tricky and involved many shifts of smaller work on the parts of a dozen people, both in the office and at home.

Dave: Why did the planetarium show folks want to involve amateur astronomers and the Night Sky Network with this kit?

Vivian: We are excited to see how many points of contact in a community – at the planetarium, under the night sky, and individually online with live shows and citizen science – will combine to create a richer experience of the content. It is part of the research component to track this web of interactions, and we'll be looking to see how multiple points of contact with similar ideas influence audience understanding.

Dave: How can interested clubs get a kit? Are the materials exclusive to the Night Sky Network?

Vivian: Astronomy clubs can receive a kit by becoming an active member of the Night Sky Network and regularly reporting on their events. It's free and offers many benefits beyond the toolkits. Museums and planetariums can also sign up to receive a kit while supplies last: *bit.ly/requestbigastrokit.*

Dave: Where can folks learn more about the Big Astronomy program? Is there any way to watch the show?

Vivian: For now, the show is being streamed online by participating planetariums, and you can find more information on how to join via the Big Astronomy website. These can include live interviews with observatory staff and scientists that give a richer experience and show you what it's like to work in these incredible observatories. In the future, we will also release a flat-screen version that can be played in other settings.

You can find more information on Big Astronomy at *bigastronomy.org* and on the Night Sky Network at *nightsky.jpl.nasa.gov.* Keep looking up – and may you have clear skies!

—Dave Prosper and Vivian White

Full STEAM Ahead

GOBSMACKED!

For many of us in the League, we joined an organization that, unbeknownst to us, had a very rich history, involving some of the most notable people in astronomy. I found out on the League's business meeting Zoom call in July that AL will have its 75th Anniversary in 2021. I was sent a 130-page document on the League's history, compiled in the late 1990s and early 2000s, to help me better understand our founding and help my plan to celebrate the occasion. I was totally gobsmacked, utterly astounded, bewildered, overwhelmed, and blown away by the heroic historical figures and organizations that collaborated to realize one ultimate plan: a national association for amateur astronomers!

However, my personal balloon was burst at the same time, since I had thought my plan to connect amateur telescope making and STEAM with families was a huge deal. Guess what? These were the cornerstones of the League's genesis, so it was not a new concept. I learned that there had been junior societies or clubs all over the nation, and that students had presented papers at our conventions. I came to realize it's like *Back to the Future* – instead of establishing something new and cool, I realized I am raising the Titanic! These revelations are a game-changer to me, and of course, my creative gene immediately shifted into hyperdrive, planning the Astronomical League's 75th anniversary year.

I had just finished the AL 2021 calendar, but with the upcoming anniversary, I decided to add historical information in the squares instead of general astronomy and space trivia. I believe this will be an eye-opener for the membership, like it was for me. As in years past, these will be available at the League online store at *store.astroleague.org.*

I reached out to the organizations that the League has partnered with from its inception in hopes that this celebration would be an astronomical family reunion of sorts. My goal is that each month I will feature a theme or topic and include "how to" live sessions and general information from our partners and friends from various astronomical organizations (as well as Explore Scientific and Teeter's Telescopes), with more connections still in the works.

I will also feature the pertinent Astronomical League Observing Program, vendors or suppliers, and virtual star parties every month. There is a plan to get a web page constructed in time for the start of the 2021 festivities, broken down by month, with URLs and resources for families and students. The goal is to lay out the full year agenda so that your club or society can make plans to join us in our celebration. More details will be forthcoming, followed by a monthly update email, so please check with your ALCORs.

2021 75TH ANNIVERSARY CALENDAR OF EVENTS

January will be comet month, featuring a profile of Leslie Peltier, a possible live session with a notable comet hunter, and observing and imaging sessions. Resources will include a recipe for making your own comet. **February** will feature imaging and International Women in Science Day. Sessions with women who have degrees in science and a female imager from AAVSO on "How to Image" will be the highlights for the month. There will also be a new League award for junior to senior high school female imagers of deep-sky or planetary objects, sponsored by Explore Scientific. **March** will feature accessible astronomy and profile G. R. (Bob) Wright, a dedicated League volunteer for whom the Service Award was named. Sessions will be hosted by Dr. Donald Lubowich, who will share his work on outreach for the visually impaired and will share the League's new partnership with NASA. **April** will celebrate our late president, Bill Bogardus, who was born this month. Another old friend of the League, the American Meteor Society, will host sessions on hunting, observing, and imaging meteors. The night sky will be the **May** focus as the weather warms and outreach (hopefully) gets into full swing. The League's namesake for youth awards, Jack Horkheimer, will be featured this month. Sessions on the constellations and the League's Sky Puppies and Beyond Polaris programs will help novices navigate the night sky. **June** will feature stars and our friends of many years, AAVSO. The profile will be Dr. Harlow Shapley, who founded the Astronomical League. **July** is nebula and galaxies month, and will have sessions on imaging and observing deep sky objects. Also this month, Mars will be in opposition, so we will look to image and sketch the Red Planet. The profile will be Charles Federer Jr., the first editor-in-chief of *Sky & Telescope* magazine. In 1947, he suggested that the AL form eight regions. **August** will feature Jupiter and Saturn, which will be at opposition this month. Our long-time friends at ALPO will host sessions on observing and imaging these objects. **September** is amateur telescope making month, with the Springfield Telescope Makers (of Stellafane fame) sharing expertise on mirror grinding, along with Rob Teeter of Teeter's Telescopes showing a "Birth of a Telescope" from start to finish. The profiles this month will be John Dobson of the Sidewalk Astronomers, Albert G. Ingalls of *Scientific American* magazine, and his mentor Russell Porter, founder of the Springfield Telescope Makers. **October** focuses on the Moon and how to image and sketch this celestial body in all its phases (highlighting the League's Lunar Observing Programs and Sketching Program). **November** is nebula and supernova month, but other deep-sky objects will also be featured. There is also an eclipse this month. The profile will be Ed Halbach, who on November 5, 1947, became the first elected president of the Astronomical League. But the main reason why we celebrate this year culminates on November 15 – on this date in 1946 we became a viable organization. We will raise a cup and toast to another 75 years!

You can help planning in several concrete ways. If your club has students who would like to share their interest or course of study with a live session for 2021, please contact me at *astroleague_steam@cox.net.* I am also generating a youth society directory for future projects. If your club hosts virtual star parties please contact me so we can feature virtual star parties over the 11-month celebration. I have one confirmed and another pending, so it's on a first-come, first-served basis. If you can contribute in other ways, please contact me and I will try to slot you in where available.

The event list is growing and changing as we prepare for 2021, still not knowing what sort of outreach and meetings will be possible. I hope for the best, and have planned for an eventual back-to-normal scenario.

On behalf of the Astronomical League's leadership, please take this as your personal invitation to join us for an 11-month 75th anniversary celebration. It will be an event that I hope will be fondly remembered by the League's members and our friends and partners, old and new. I plan on seeing you all next year! Full STEAM ahead!

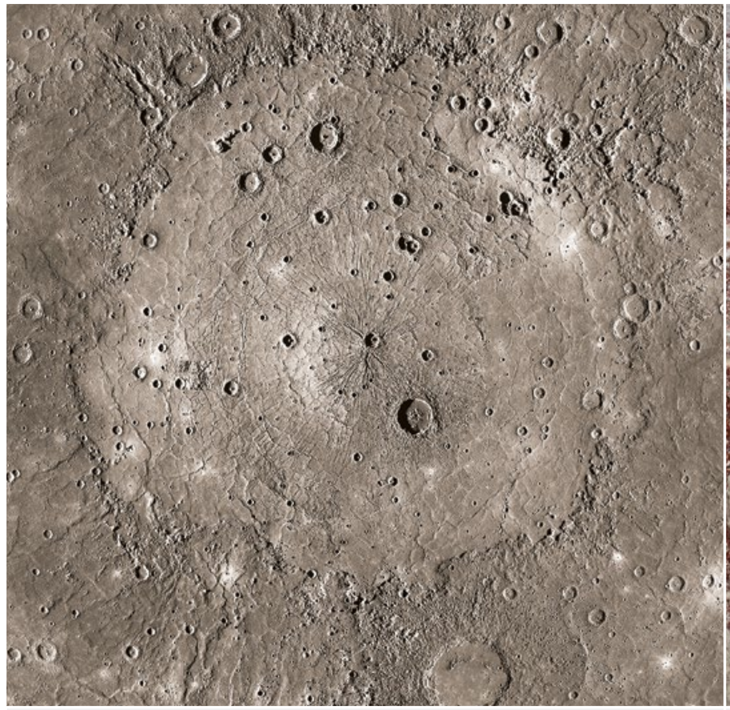
—Peggy Walker

Wanderers in the Neighborhood

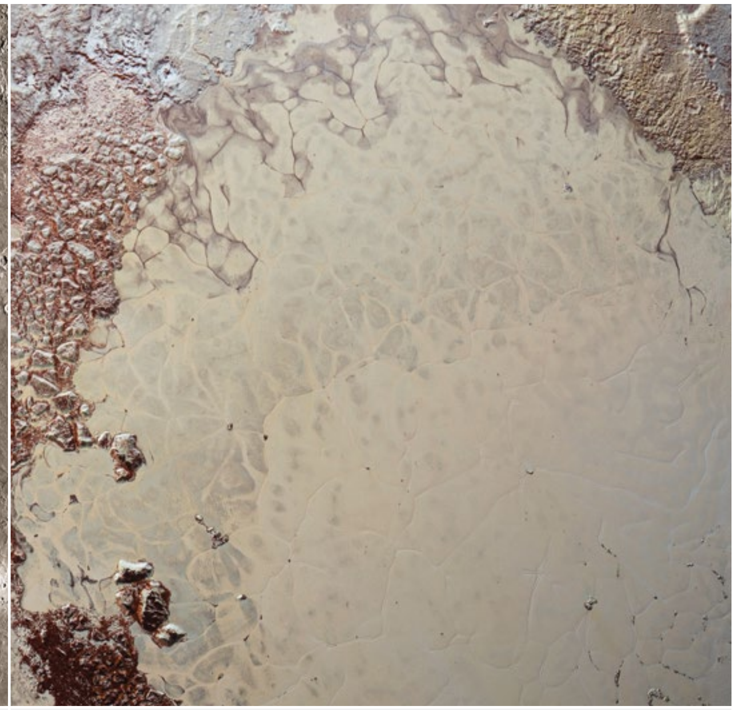
MERCURY AND PLUTO: SMALL PLANETS AT THE EXTREMES

Before 2005, Pluto was considered a planet and every schoolchild learned about the nine planets in our Solar System. Pluto and Mercury were the two small planets that were like bookends at its extremes. It almost seemed that planetary formation began with little Mercury, grew through the rocky planets, reached a maximum with giant Jupiter, and then started declining down to Pluto, then considered the smallest planet in the Solar System.

More recent discoveries have added the Kuiper Belt, extending from the orbit of Neptune all the way to the edge of the Solar System, where many more Pluto-sized objects have been discovered. These new objects caused astronomers to reconsider the definition of a planet. Pluto was reclassified to a dwarf planet, in part due to its size, having only about half the diameter of Mercury. Dwarf planets receive a minor planet designation, so we now have minor planet 134340 Pluto. Many people still remember these two as



Mercury has only been visited by two spacecraft, both sent by NASA. Mariner 10 visited between 1974 and 1975, passing by the planet three times but never orbiting it. This image was taken by the MESSENGER spacecraft that did enter orbit around Mercury. This view of Caloris Planitia shows one of the largest impact basins in the Solar System. The basin has been filled by volcanic plains that have been pockmarked by newer craters. These newer craters bring darker material up from the basin floor that may provide clues to the composition of the floor. Credit: JPL/NASA



The polygonal cells in the Sputnik Planitia area of Pluto's Tombaugh Regio demonstrate the slow motion of nitrogen ice on Pluto's frigid surface. Heat from radioactive decay in the core warms the bottom of the basin and warmer nitrogen ice rises toward the surface. There it cools and sinks back toward the bottom, providing a continuous (though very slow) motion of material in the basin. It takes over a hundred years for material to make a single cycle. Credit: NASA / Johns Hopkins University Applied Physics Laboratory / Southwest Research Institute

the two smallest "planets."

Both objects are rocky (to differing degrees), but Mercury is nearly three times as dense as Pluto. They both have a higher-density core (mainly rock in the case of Pluto, iron in the case of Mercury) including radioactive elements. Mercury's core occupies nearly 85 percent of its volume, while Pluto's core is only 34 percent of its volume.

Pluto has sufficient radioactive elements to heat the interior of the planet, allowing the heavier elements to sink to the center while the lighter ones floated to form a mantle above it. Mercury's core, on the other hand, has the highest iron concentration in the Solar System. Mercury's high proportion of iron and heavier elements is probably due to the early solar nebula slowing down the lighter elements so they fell into the proto-Sun, leaving the heavier elements to be accreted by Mercury. The heavier elements later sunk to the core of the planet.

Above its core, Mercury's mantle is made primarily of silicates, which are minerals composed of silica (silicon dioxide), quartz for example. At the other end of the Solar System, Pluto's mantle is believed to be primarily water ice. Water ice is less dense than silicates, contributing to Pluto's lower overall density. Pluto's core produces enough heat to keep the mantle near the core in the liquid state, but the water further from the core turns to slush and then to solid ice as the temperature drops with the increasing distance.

Pluto's crust is cold enough that it is 98 percent frozen nitrogen, with traces of carbon monoxide, giving the surface an orange tinge. The surface is active, with the nitrogen ice shifting very slowly in some areas, driven by gravity and convection. Mercury has a rocky surface and looks much like our Moon, with craters, maria, and plateaus. It is generally gray, with very little color and no movement.

Mercury is heavily cratered, just like the Moon. With almost no atmosphere, the craters are not eroded by air or water and remain undisturbed for long periods of time. Mercury's craters vary from fresh craters with rays radiating outward to ancient craters that are just barely recognizable because more recent impacts have eroded them away.

The largest crater on Mercury's surface is the Caloris Basin, with a diameter of 960 miles (1550 kilometers). The impact that created this crater was so powerful that it created a concentric ring of mountains around the crater more than a mile high. On exactly the opposite side of Mercury, there is a disturbed area called the "Weird Terrain." It is unknown if shock waves from the impact traveled around Mercury and converged in this area, disturbing the surface, or if ejecta from the impact converged in this area, pummeling the surface with hundreds of overlapping craters.

Pluto's surface is a layer of nitrogen ice that is a few miles thick. Mixed in with the nitrogen ice are trace amounts of methane and carbon monoxide. The color and brightness contrasts are as vivid as those seen on Saturn's moon Iapetus. The mountains here are white, composed of water ice. The "heart" has been named Tombaugh Regio and its western lobe is named Sputnik Planitia, a basin of frozen nitrogen and carbon monoxide. A close-up view shows this 700-mile-wide basin is composed of polygonal cells.

Nitrogen-ice glaciers flow down from the surrounding mountains into the basin. The nitrogen ice on the basin floor is warmed by the heat from the core and flows upward. This warmed nitrogen ice starts to cool and is pushed off to the sides by incoming warm ice. Eventually the formerly ice has cooled so much that it sinks back toward the bottom of the basin.

Further from the pole, warm nitrogen ice still rises up, but now under the center of the polygonal cells New Horizons observed. The cooling nitrogen ice is pushed to the edges of the polygonal cells where it has cooled enough to sink back toward the bottom of the basin to be reheated. Nitrogen gas escapes from the nitrogen ice surface of the basin and condenses on the mountains to eventually join the glacial flow back into the basin. Some of this nitrogen gas even escapes the mountains to form a hazy atmosphere around Pluto, a feature that Mercury lacks.

Mercury is currently static, although in its youth it was volcanically active, filling the basins like the Caloris Basin with lava that eventually cooled to form maria similar to those on our Moon. This makes Mercury look similar to the Moon. Its weak magnetic field (just one percent that of Earth) deflects some of the solar wind that would otherwise strike the surface. Pluto has no magnetic field based on New Horizons measurements.

These two small planets are similar in some ways, yet very different in others. Mercury is very hot (on the sunlit side), while Pluto is very cold. Yet both have basins and impact craters on their surfaces. They make an interesting pair of bookends for our Solar System, even if one of them is now considered a dwarf planet.

—Berton Stevens

Deep-Sky Objects

ARIES' BEST GALAXY

The constellation Aries dates back to ancient times. In mythology, Aries was the ram whose golden fleece was sought by Jason and the Argonauts. Early Chinese astronomers saw it as a dog, while Arab astronomers depicted it as a lamb. Aries was an important constellation 2000 years ago because it contained the point where the ecliptic intersected the celestial equator. The Sun passes this point from south to north at the vernal equinox. Although precession of Earth's spin axis has moved this point into Pisces, this intersection is still called the first point of Aries.

Most astronomers would be hard-pressed to name a deep-sky object in Aries, or any stars other than Hamal and Sheratan (Alpha and Beta Arietis), the two brightest stars in the constellation. It's not because Aries is a small constellation. Among the 88 constellations, Aries ranks 41st in size. Coincidentally, it also ranks 41st in the number of naked-eye stars, that is, stars brighter than sixth magnitude. Aries just doesn't contain any bright deep sky objects. There are no Messier objects in Aries. There are 80 NGC objects in Aries, roughly one percent of that catalog. But all of them are galaxies, with only one brighter than magnitude 11.

Between 1784 and 1786, William Herschel discovered 25 galaxies in Aries brighter than magnitude 14 using his 18.7-inch Newtonian reflector. His son John discovered another five between 1828 and 1831. So, between the two of them, the family netted half of the NGC galaxies in Aries brighter than magnitude 14. The brightest of these, which William discovered, is NGC 772.

Shining at magnitude 10.3, NGC 772 is easy to find with 6- to 8-inch telescopes. To star hop to the galaxy, start at the star Sheratan (Beta Arietis), a magnitude 2.6 star near the western edge of the constellation. From Sheratan, hop one and a half degrees south to the star Mesarthim (Gamma Arietis). Slightly brighter than magnitude 4, Mesarthim is an easy naked-eye star. Hop another one and a half degrees east-southeast of Mesarthim to arrive at NGC 772. I can usually hit the location of NGC 772 with my red-dot finder and the galaxy is in the telescope's eyepiece. Both Sherartan and Mesarthim can be placed in the same field of view as NGC 772 in an 8x50 finderscope. But at magnitude 10.3, the galaxy is nearly impossible to see in the finderscope. Knowing where it is with respect to the two stars still allows its location to be centered in the finder.

NGC 772 is a mostly face-on spiral galaxy. It measures 7.2 x 4.3 arcminutes in size with the longest dimension oriented 45° from a north-south line. In an 8-inch telescope, the core of NGC 772 may appear star-like with a faint glow of the remainder of the galaxy surrounding it. Larger telescopes will begin to bring out the asymmetric shape of the galaxy as well as 13th-magnitude NGC 770, a companion galaxy to NGC 772.

My image of NGC 772 was taken with a 10-inch f/6 Newtonian with a Paracorr II coma corrector and a SBIG ST-2000XCM CCD camera. The exposure was 180 minutes. North is up and east to the left. The small elliptical galaxy south of NGC 772 is NGC 770.

Like the Milky Way, NGC 772 has a few good-sized and numerous tiny satellite galaxies. Many of them (between 16th and 18th magnitude) are visible as fuzzy dots on my image. The asymmetrical shape of NGC 772 is likely the result of gravitational interaction with the elliptical companion NGC 770, which is probably more massive than any satellite galaxy of either the Milky Way or the Andromeda Galaxy (M31). NGC 772 is about twice the size of the Milky Way, so it's not surprising that it could hold a larger satellite galaxy in orbit around it, if indeed it has NGC 770 bound in an orbit.

Detailed images of NGC 772 show curved streams of what may have once been outer spiral arms extending all the way to NGC 770 and a few other satellite galaxies. Astronomers have detected bridges of stars between our galaxy and its satellites, too. Imagine the view you would have of NGC 772 or the Milky Way if you lived on a planet circling a star in one of those intergalactic bridges!

—Dr. James R. Dire

The author's image of NGC 772

From Around The League

40TH ANNIVERSARY PELTIER AWARD RECIPIENT IS HOWARD J. BREWINGTON

2020 has been quite the year of negative news. But now, some positive news: this year is the 40th anniversary of the founding of the Astronomical League's Leslie C. Peltier Award! During this time, some of the top amateur or pro-am observers in this country (and two from abroad) have received this honor.

This year's recipient, Howard J. Brewington, is a versatile observer who shares a love for comet-hunting with Leslie Peltier, having discovered five comets himself (see photo). His biography, provided by his wife, Maya, documents his remarkable story:

Howard J. Brewington received his first telescope, a Sears 35 mm tabletop refractor, in 1961 at age nine. By his own testimony, however, his interest in astronomy ran hot and cold until 1985, when the return of Halley's Comet changed him forever. Brewington excitedly purchased photographic equipment and built a darkroom in his South Carolina Victorian home, and astrophotography became his new passion.

As Halley retreated from the Sun in 1986, Comet Bradfield (1987s) soon graced the evening sky. Brewington was fascinated that this comet had been discovered by an amateur systematically scanning the night sky with a homemade telescope. In late 1987, Brewington declared his plans to build comet-hunting telescopes and become the first South Carolinian to discover a comet. His design included hand-grinding 8-inch and 16-inch primary mirrors himself.

Friends in the Midlands Astronomy Club of Columbia, South Carolina, thought his comet-hunting aspirations would be a waste of time given the local sky conditions. Yet, on November 16, 1989, after 230 search hours, he found South Carolina's first comet with his homebuilt 8-inch reflecting telescope. Shared with another amateur in Norway, this object was named Comet Aarseth-Brewington (1989a1).

The following month, he independently discovered a second comet from his home state. However, bad weather delayed his search routine by a couple of nights, so he did not receive credit for what became Comet Skorichenko-George (1989e1). Nevertheless, Brewington had become consumed with comets. In the fall of 1990, he sold his home and electronics business and moved to southern New Mexico to secure better sky conditions.

He built a comet-hunting observatory on a 7300-foot ridge east of Cloudcroft, and his relocation produced four more comet discoveries by 1996. Two of his New Mexico comets, 97P Metcalf-Brewington and 154P Brewington, had short-period orbits of about ten years. NASA's Near-Earth Object (NEO) surveys began finding most comets well beyond the range of visual comet hunters, so in fall 1999, he moved back to his home state and enrolled at the University of South Carolina's main campus in Columbia.

In the summer of 2002, Brewington graduated with honors and was hired by New Mexico State University to operate their 2.5-meter telescope as part of the Sloan Digital Sky Survey. He and his wife, Maya, bought a home in Las Cruces near the main campus. After retiring from NMSU's astronomy department in 2015, Brewington became more involved in the Las Cruces Astronomical Society and served as club president in 2017/18. His most recent astronomy-related interest is hunting and imaging micrometeorites – space and comet dust. He collects these sub-millimeter objects, along with other magnetic debris, from the flat roofs of large buildings with a neodymium magnet. He then spends hours scanning his collections with a stereomicroscope. Although he's found hundreds of these extraterrestrial objects, he confesses that finding comet dust is not nearly as exciting as discovering an unknown comet. Yet, he's still having fun with his life-long passion for astronomy.

As you can see from the above biography, Howard is a true disciple of Leslie Peltier and a most worthy recipient of this 40th anniversary award!

The Peltier award committee is always in search of new nominees. Please contact the committee chair, Dr. Roger Kolman, at *rskolman@yahoo.com* for more information.

—Roger S. Kolman

CALL FOR NOMINATIONS

The two-year term of the office of League secretary and the three-year term of the office of League treasurer both expire on August 31, 2021.

The secretary position involves preparing and distributing minutes of all council, business, and executive committee meetings, maintaining officer calendars, preparing notebooks of current by-laws and standing resolutions for council meetings, and timely filing of annual or biennial corporate reports with the State of Missouri.

The treasurer position involves maintaining League financial accounts, issuing monthly financial reports, preparing annual budgets, paying and issuing bills, monitoring costs, collecting and recording membership dues, maintaining inventories of League property, conducting audits when required, and timely annual filing of IRS Form 990.

Candidates are asked to submit a background statement of 250 words or less and a photo, both for publication in the *Reflector*. Background statements should list qualifications and/or reasons for seeking the position. Nominations, along with accompanying background statements and photos, must be submitted to the nominating committee chair, Chuck Allen, at *chuckallen@gmail.com* no later than March 31, 2021, in order to be included in the *Reflector* and on the ballot.

ALTERNATE CONSTELLATIONS OBSERVING PROGRAM

The Astronomical League has approved the new Alternate Constellations Observing Program. The focus of this program is to observe, sketch, and investigate the origin of several constellations that are not part of the official list of 88. It also includes studying and observing the constellations of other cultures, both ancient and contemporary.

The program is split into two parts:

Obsolete Constellations consists of many of the now-obsolete constellations that were developed in the Western world to fill in the gaps between the ancient ones, but that did not make the official list of 88 that we use today.

Constellations of Other Cultures is a review of star groupings as seen by indigenous peoples around the globe. This includes examples from North America, East Asia, Africa, Mesoamerica, Oceania, and many more. This section also includes additional exercises that may help you understand the effects of precession and where we are in the Milky Way.

In all cases, there are many interpretations of what the patterns look like and stand for. Any reasonable resource is acceptable; library resources, astronomy texts, and the internet (even Wikipedia!). Even from a city location you can usually trace out the constellations using only your eyes or maybe adding a small pair of binoculars. You will not have to travel to a dark-sky site, and the only cost will be that of the binoculars and maybe some books if you choose to buy them.

The goal of this program is to expose people not only to the obsolete Eurocentric alternate constellations, but also star patterns from other cultures. There is both amazing variety and surprising commonality to the star groups across time and the breadth of the whole world. The intent is to discover how constellations developed and how important they have been to us in the past (and still are today).

If you have any questions, please contact me at *allenb_young@yahoo.com*. Program rules and submission details are at *astroleague.org/content/alternate-constellation-observing-program*. Please note that due to differing interpretations of ancient constellations, *you can substitute a constellation from the same culture/geographic area* if you have difficulty identifying the constellations of other cultures. For example, "Te Te, The Two Groups (Akkadian)" may be replaced by another Asian constellation, as long as all of the requirements of the program are met by the substitute observation.

—Brad Young

CALL FOR AWARD SUBMISSIONS

The application or nomination deadlines for 2021 Astronomical League awards is March 31, 2021. Award information, including applications and applicant qualifications, can be found on the League Website award page at *astroleague.org/al/awards/awards.html.* Receipt of all submissions will be confirmed by email. If no confirming email is received, please contact League vice president Chuck Allen (see national officer list) immediately.

YOUTH AWARDS

The League offers five major youth awards, including the National Young Astronomer Award, the Horkheimer/Smith and Horkheimer/D'Auria Service Awards, the Horkheimer/Parker Imaging Award, and the Horkheimer/O'Meara Journalism Award.

National Young Astronomer Award. Qualified U.S. citizens (or U.S. school enrollees) under the age of 19 who are engaged in astronomy-related research, academic scholarship, or equipment design are encouraged to apply for the National Young Astronomer Award, now in its 28th year. First- and second-place winners receive plaques, Explore Scientific telescope prizes, and expenses-paid trips to the League's national convention (U.S. travel only). Applications must be emailed to *NYAA@astroleague.org* by March 31.

Youth Service Awards. Qualified League members under the age of 19 who are engaged in service to the amateur astronomy community are encouraged to apply for the Horkheimer/Smith and Horkheimer/D'Auria Youth Service Awards. Club or regional officers may nominate candidates. The Horkheimer/Smith winner receives a plaque, a $1,750 cash prize, and an expenses-paid trip to the League's national convention (U.S. travel only). The Horkheimer/D'Auria winner receives a plaque and a $1,000 cash prize. Applications or nominations must be emailed to *HorkheimerService@astroleague.org* by March 31.

Youth Imaging Award. Qualified League members under the age of 19 who are engaged in astronomical imaging are encouraged to apply for the Horkheimer/Parker Youth Imaging Award. Club or regional officers may nominate candidates. The winner receives a plaque and a $1,000 cash prize. Applications or nominations must be emailed to *HorkheimerParker@astroleague.org* by March 31.

Youth Journalism Award. Qualified League members, age 8–14, who are engaged in astronomy-related writing are encouraged to compete for the Horkheimer/O'Meara Youth Journalism Award. Club or regional officers may nominate candidates. The winner receives a plaque and a $1,000 cash prize. Second and third places receive cash prizes of $500 and $250, respectively. Applications or nominations must be emailed to *HorkheimerJournalism@astroleague.org* by March 31.

MABEL STERNS AWARD

The Mabel Sterns Award acknowledges the important role of club newsletter editors. Any club officer may nominate a newsletter editor by emailing a link to an online newsletter or a copy of the club's print newsletter as a PDF file to *sternsnewsletter@astroleague.org* along with a nomination cover letter (PDF) that includes the name and address of the nominee and an attached JPEG photo. Nominees and nominating officers must be League members. Deadline: March 31.

WEBMASTER AWARD

The League's Webmaster Award recognizes excellence in the creation and maintenance of society web pages. Club officers may nominate a webmaster by emailing a newsletter link to *WebmasterAward@astroleague.org* along with a nomination cover letter (PDF) that includes the name and address of the nominee and an attached JPEG photo. Nominees and nominating officers must be League members. Deadline: March 31.

ASTRONOMICS SKETCHING AWARD

The Astronomics Sketching Award recognizes the fundamental role that sketching plays in observing. The award – open to League members of all ages – provides cash prizes for first place ($250), second place ($125), and third place ($75). It is made possible through the generosity of Astronomics, *astronomics.com*. Sketches should be submitted as high-resolution JPEG files (10 megabytes maximum) along with a JPEG photo of the applicant to *sketch@astroleague.org*. Winning sketches may be published in the *Reflector* and on the web. Deadline: March 31.

—Chuck Allen

YOUR ASTRONOMICAL LEAGUE IS GIVING AWAY UP TO ELEVEN LIBRARY TELESCOPES!

Through the vision of the Horkheimer Charitable Fund, the Astronomical League is again offering a free Library Telescope to a lucky Astronomical League club in each of the ten AL regions and to a member-at-large.

The Library Telescope consists of an Orion 4.5-inch StarBlast Dobsonian or a Zhumell Z114 (or equivalent), a Celestron 8–24 mm zoom eyepiece (or equivalent), and a name plate commemorating the late Jack Horkheimer. The value of this opportunity is approximately $300; the potential of the program is enormous.

We prefer that you submit your completed entry form electronically so that the Astronomical League national office receives it by the deadline of Friday July 16, 2021. Please email it to *HorkheimerLiTel@astroleague.org*. If mailed, the entry must be postmarked no later than July 16, 2021. The winning entry for each region will be selected August 5, the date when ALCon 2021 is currently scheduled. Full details of this program can be found at *astroleague.org/content/library-telescope-program*.

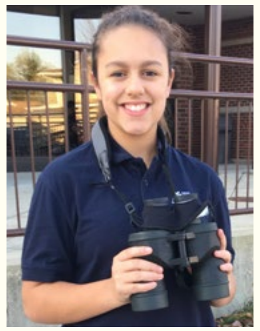
The Library Telescope Program is a great club project that brings members together while benefiting their community. Indeed, it is the perfect outreach program!

HOW KIDS CAN BE INTERESTED IN ASTRONOMY

Astronomy is a very important factor in our lives, and it interests many people, but in my opinion, it interests mostly adults. Astronomy should be a topic that appeals to all ages. Because astronomy is the study of objects outside of the Earth's atmosphere, it can satisfy our fundamental curiosity about the world we live in and answer the "big questions." Some ways that kids can be more interested in this branch of study is to make learning fun, simple, and interactive.

A way to get learners interested in anything is to make the lesson fun. Especially for kids, when you do something fun, they will remember it more. For example, on August 21, 2017, there was a total solar eclipse, where the Moon blocked one hundred percent of the Sun. I remember my mom took me and my six younger siblings to the Adler Planetarium in Chicago. We stood out on the porch and looked at the eclipse with special glasses to protect our eyes. It was so cool how you could see the Moon slowly cover the Sun as the sky became darker. Afterwards, we went inside to watch a movie about the eclipse looking up at a huge screen. This event was very fun, and it made me more interested in astronomy.

Another way to get kids interested in astronomy is to make it simpler for them. One way to do this is to have them use binoculars instead of telescopes. Even though a telescope may seem fancier and more advanced, some star clusters are



better seen with binoculars. For example, the Pleiades is better seen with a pair of binoculars because telescopes "may, theoretically, show fainter stars, but they can only show a small part of the cluster" (Philip Pugh, *bestbinocularsreviews.com/blog/viewing-pleiades-binoculars-03*). Binoculars are also easier to travel with, lighter to carry, and much simpler for kids to use.

Another way that will get kids excited to learn about astronomy is to make it interactive. I do a lot of experiments in science. Experiments are a type of "hands-on" activity that makes learning interesting. Observing the sky with your eyes, binoculars, or a telescope is a hands-on activity where one uncovers the beauty and magnificence of the celestial world. Twice every year, I go up to Wisconsin to visit my grandparents. I have great memories of going out at night and looking at the stars through a telescope with my grandpa. In Chicago, I can't really see many stars because the city lights are so bright. When kids are able to go out and observe, they have fun and become more interested in what they are learning.

I only mentioned three of the many ways to get kids interested in astronomy. If the activity is fun, simple, and interactive there will be no trouble in captivating kids' interest in astronomy.

—Lucia Castillo

Editor's Note: *Last issue we announced that Lucia Castillo is the first place Horkheimer/O'Meara Youth Journalism Award winner. This is her winning essay.*

Public Outreach During a Pandemic

By Jan Rush, Al Lamperti, and Gary Trapuzzano

According to *Sky & Telescope* magazine's April 2020 issue, effects of the COVID-19 pandemic on spaceflight, space science, and amateur and professional astronomy have been profound. Planned space missions have been delayed or cancelled. More than 100 of the largest Earth-based telescopes were shuttered for a time since their teams of operators were inconsistent with distancing guidelines. Amateur astronomy clubs rapidly switched their face-to-face meetings to online, and many organizations began holding virtual star parties. Soon our calendars were cluttered with a profusion of similar-looking Zoom meetings, leaving most of us longing for alternate ways to pursue our hobby.

Al Lamperti made good use of Night Sky Network materials for his Moon station, including a demonstration of crater formation and explanation of prominent features of the Moon. Photo credit: Tracey Trapuzzano

Celestial objects were projected on a large (84-inch diagonal) screen. Jupiter and the Galilean moons, projected on the screen, were a crowd pleaser. Photo credit: Gary Trapuzzano

After cancelling in-person activities for three months, the Delaware Valley Amateur Astronomers (DVAA, based in the Philadelphia area) decided to try a different face-to-face public star party format fully consistent with local and Centers for Disease Control guidelines and designed to avoid inadvertently spreading the virus. Sharing telescopes and eyepieces was impossible at that stage in the pandemic since the virus is detectable in tears and can theoretically be spread via a contaminated eyepiece. We christened our idea a star party "picnic," and held the event in a community park that allowed 40 people to attend. There was no food at this "picnic"; instead we feasted on celestial wonders. We have now held two similar events, and with each event we evolve.

At each event so far, attendees were greeted at a welcome station supplied with DVAA promotional materials, "sky tonight" handouts, hand sanitizer, antiseptic wipes, and disposable masks. Attendees brought their own lawn chairs or blankets and their own binoculars, and they distanced themselves, spread across a large field. Masks were required for everyone older than age six. DVAA members set up stations that could be visited by small numbers of socially distanced people during twilight. The topics included the Moon, how to use binoculars to view celestial objects, and an introduction to popular astronomy apps. Since some attendees might attend several of our star parties, we plan to rotate the stations at future star parties, covering different topics at each event. When the sky became dark enough, we moved on to a laser tour of constellations, bright stars, and planets, emphasizing objects that attendees might be able to locate with their binoculars.

In order for the attendees to actually "see" the objects described by the main presenter, three high-sensitivity video cameras, each configured for a different field-of-view (FOV), were used to project a live image of the sky on a large (84-inch diagonal) screen. A small refractor (80 mm, f/7) fitted with a Revolution Imager video camera (0.5° by 0.37° FOV) was used to show details of the Moon's craters and views of the planets while awaiting darkness. To show larger objects during the main presentation, we switched between using a wide-angle SLR camera lens (10 mm, f/2.8) on a Revolution Imager R2 camera (21° by 16° FOV), and a normal lens (50 mm, f/1.4) on a MallinCam Micro-EX video camera (5.6° by 4.2° FOV) to simulate the view through binoculars. Toggling between these two cameras enabled us to show asterisms such as the bowl and handle of the Big Dipper, small constellations such as Sagitta and Cassiopeia, and small clusters such as the Coathanger (Collinder 399). We were also able to show very small clusters such as the Owl/ET Cluster (NGC 457) using the small refractor imaging setup.

This approach wasn't without technical challenges. Our LCD projector required almost 200 watts of power, which translated into 30 amps of current being drawn from the 12-volt car battery powering an AC inverter. This quickly drained the battery, so it was necessary to run the car during the presentation. We also needed to determine the best fields-of-view for orienting the attendees to the portion of the night sky being discussed, providing a representative image of what they could expect to see in binoculars, and approximating a closer view of what they would see if looking through a small telescope.

This star party format requires extra foresight and planning in order to be successful. We developed a detailed outline of constellations and objects to be pointed to in the sky with notes for the camera operators regarding which objects in that celestial region would be projected on screen. While the main presenter discussed the area of sky shown by the current camera, one of the other cameras was shifted to the next object to be projected. This alternating camera approach allowed time for the camera operators to find the next target, focus their equipment, and be ready to project the next image when the presenter was ready, resulting in a seamless presentation.

A portable, battery-operated sound system helped to reach the distanced crowd, but how best to safely pass a microphone around among the presenters in the age of COVID-19? With the attendees distanced, many could not see the presenter's laser pointer, so DVAA members with laser pointers stationed themselves around the crowd and mirrored the pointer of the presenter. With the attendance caps imposed by park management, events must be run with fewer staff than a usual star party. And in order to comply with social distancing guidelines and attendance caps, a system for pre-registration of attendees was essential.

Until we can go back to sharing our telescopes and eyepieces, this new format has wonderful potential to connect with the public in new ways. We will continue to refine our content and presentation, learning and improving as we go. Compared to our 2019 public star parties, this format demands greater communication and cooperation between presenters and more advance planning, which also provides more opportunities for us to learn from each other. ✷

Acknowledgements: The success of these events was a team effort. We appreciate the important contributions of Andrew Hitchner, Roy Patton, Wayne Reed, Tracey Trapuzzano, and Michael Tucker.

My Herschel Objects Project Is Complete!

By Larry McHenry

It is done! As of May 13, 2020, I have completed observing all 2482 identifiable objects of the Herschel 2500 Catalog.

My last catch was H II-840, a pretty little one-arm galaxy, NGC 3978, in Ursa Major.

The idea for this Herschel Objects project started at the end of 2012, as I was wrapping up a constellation survey based on the *Night Sky Observer's Guide*. I realized that my observations would already include a large number of the Herschel 400 objects. After identifying all the Herschel 400 objects that I had previously observed, it took me less than a year to finish the Herschel 400 list. For this phase of the project, I used the Astronomical League's "Herschel 400 by Constellation" list and their *Observe the Herschel Objects* booklet. I then downloaded the AL's "Herschel II" list of the next 400 objects and began hunting those.

By the autumn of 2016, I was down to the last 60 objects and was wondering what my next project should be. Flipping through some old *Sky & Telescope* magazines, I ran across an article from the August 2012 issue by Rod Mollise on observing the entire Herschel Catalog of 2500 objects using a deep-sky video camera. This was the inspiration (and project) that I needed. I was already a video astronomer, so I began a multi-year effort to observe the entire Herschel Catalog.

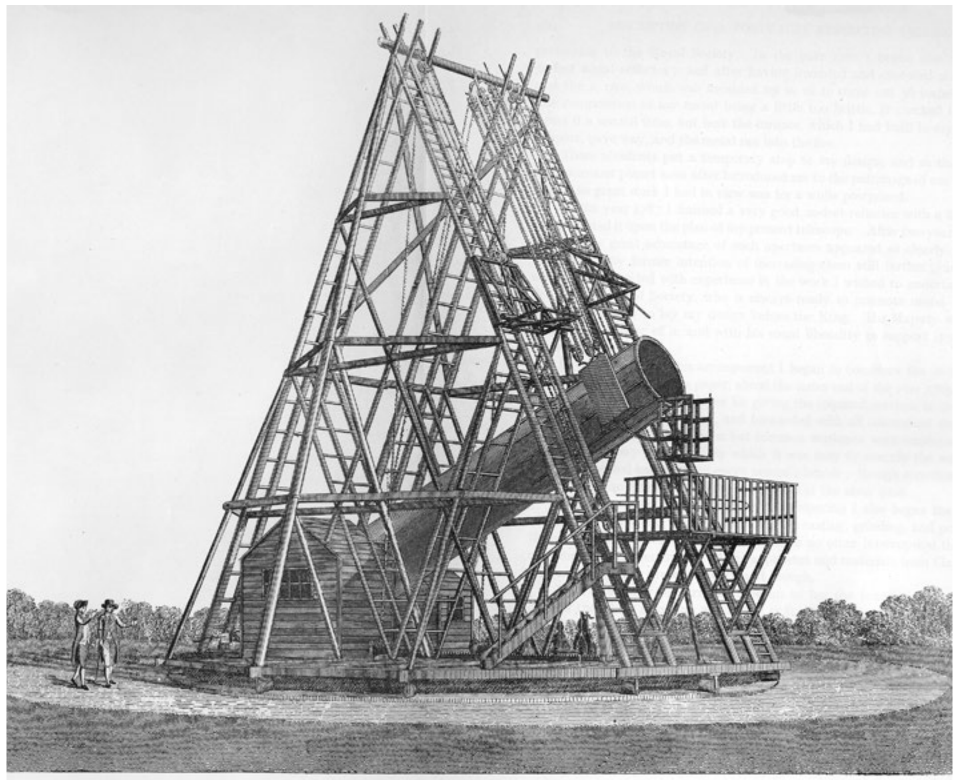
First, a little background on the Herschels:

After the Messier list, the Herschel objects are the next-most observed deep-sky objects. Most amateur astronomers know them by their NGC numbers, but they started out as a list created by British amateur astronomer William Herschel and his sister Caroline.

From 1782 to 1790, the Herschels conducted systematic surveys of the night sky in search of deep sky objects, and discovered over 2500. Herschel used two telescopes for his survey, a 20-foot reflector, which had an 18.5-inch speculum metal mirror, and later the great 40-foot reflector with a 48-inch mirror. Both telescopes' mirrors were made by the Herschels and had to be regularly repolished, as the metal mirrors were quick to tarnish in England's wet climate. When Herschel made the mirrors, he created two of each, one of which he kept polished and stored indoors, ready to be swapped out once the working mirror began to go bad. Then during the day, he would work on getting the swapped mirror repolished while he and Caroline continued their nightly observations with the fresh mirror. Most of Herschel's recorded observations were made using the 20-foot telescope, as the larger 40-foot was cumbersome to use and suffered from tube-current distortions.

Herschel's telescopes didn't have clock drives to track the stars, so instead, he would point the telescope to the meridian and let the Earth's rotation carry objects across his field of view while he was up on a ladder observing. William would call down to Caroline, at the bottom of the telescope, when he saw something interesting, and she would write down his description, the time, and where the telescope was pointing. Caroline would then quickly read this back to William and he would confirm the observation while the object was still in the eyepiece. This method allowed them to observe and record a nightly east-west strip of sky. The next day, the two of them would use their recorded observations to calculate the objects' positions on a star atlas. They would then move the telescope's elevation up or down, in preparation of the next night's survey run. Using this method, they were eventually able to observe all of the sky visible from England.

William Herschel published his deep-sky discoveries as three separate catalogues: *Catalogue of One Thousand New Nebulae and Clusters of Stars* (1786), *Catalogue of a Second Thousand New Nebulae and Clusters of Stars* (1789), and *Catalogue of 500 New Nebulae* (1802). Herschel classified his list into eight categories:



William Herschel's 40-foot telescope. (Public Domain image, via University of Chicago Libraries)

Class I – bright nebulae: These are objects of various sizes and shapes, such as galaxies, clusters, and nebulae. The one thing they have in common is that they are very bright. These are the easiest Herschel objects to observe.

Class II – faint nebulae: These objects are generally faint, such as unresolved clusters and dim galaxies. You'll need fairly dark skies and a medium to large telescope to see them.

Class III – very faint nebulae: These are mostly very, very faint objects, mainly galaxies. They require a dark-sky location, large telescope, or video/CCD camera, and a bit of luck.

Class IV – planetary nebulae: While mainly planetary nebulae, you can find some emission nebulae and galaxies mixed in.

Class V – very large nebulae: These very large deep-sky objects are not necessarily very bright. Depending on the object, you may need a dark-sky location and wide-field eyepiece.

Class VI – very compressed and rich clusters of stars: These are mainly bright resolvable globular clusters and large open clusters with numerous members.

Class VII – compressed clusters of small and large stars: These objects tend to be open clusters containing bright foreground stars, or cluster members with widely varying brightness.

Class VIII – coarsely scattered clusters of stars: This class tends to be loose, somewhat dim open clusters, best suited for wide-field eyepieces.

Within each of Herschel's categories, objects are numbered in the sequential date order by when they were discovered. Herschel Object H VII-255 may have been discovered years before object H III-81. In Herschel's time, galaxies were classified as nebulae, so there is no separate class for them, and they are mixed among the first five classes.

William Herschel's discoveries of 2500 deep-sky objects were supplemented by those of Caroline Herschel (11 objects) and his son John Herschel's southern hemisphere South African observations (1754 objects), and were published by John as the *General Catalogue of Nebulae and Clusters* in 1864. Eventually, this catalog of all the Herschel objects, along with discoveries from other nineteenth-century astronomers were combined, revised, and renumbered by astronomer John Dreyer and published in 1888 as the *New General Catalogue* (NGC) of 7840 deep sky objects.

How I accomplished the project: As I began a multi-year effort to observe the entire Herschel 2500 Catalog in 2016, the first thing I needed to do was come up with a list of the Herschel Objects. During William and Caroline Herschel's original recording and publishing of their observations from 1786 to 1802, along with subsequent reprints and revisions in the nineteenth century, there have been a number of discrepancies over misidentified or nonexistent objects.

Depending on the source, there are anywhere from the low 2400s to over 2500 actual objects. In his book *The Complete Guide to the Herschel Objects,* Mark Bratton gives a good review of the issues and historical attempts to rectify Herschel's list of objects. He eventually settles on there being only 2435 identifiable Herschel Objects. (I use his book's visual descriptions and digitized sky survey images to help compare and confirm my observations).

In addition to the above book, I also utilized George Kepple and Glen Sanner's *Night Sky Observer's Guide* and internet resources WikiSky (*wikisky.org*) and The NGC/IC Project (*ngcicproject.observers.org*) to validate my observations.

After combining, distilling, and sorting, I generated a personal spreadsheet/logbook to help in my tracking and logging. To see the entire list together, I've created a specific page for the Herschel Project: *stellar-journeys.org/herschel-tour.htm*.

Over the course of this project, I have spent 239 nights working my way through all of the Herschel Objects. Even though I really didn't get serious about completing the list until 2012, my observations stretch all the way back to 1984. All of the early observations (78 objects) are visual sketches made at the telescope eyepiece, with everything after 2001 using the video astronomy (electronically augmented astronomy, EAA) short-exposure lucky imaging technique.

For the video astronomy observations, I used four telescopes: a 50 mm f/3 refractor; an 80 mm f/6 refractor; a 6-inch Ritchey-Chrétien at f/9, f/6.3, and f/5; and an 8-inch Schmidt-Cassegrain at f/10, f/6.3, and f/3.3. All telescopes were on either SCT or CGEM mounts that could track and later utilize go-to.

The cameras used were a StellaCam EX (2.5-second exposures), a StellaCam II (8-second exposures), a Samsung SDC 435 (8-second exposures), a Peltier-cooled, wirelessly controlled StellaCam 3 (unlimited exposures), and finally a ZWO ASI294MC Pro camera used in EAA mode (generally around 120-second exposures).

While I prefer going to dark-sky locations, such as Pennsylvania's Cherry Springs State Park, for my observing, using near-real-time deep-sky video astronomy cameras has allowed me to pull in galaxies fainter than 14th magnitude not visually possible from my backyard observatory, located within ten miles of downtown Pittsburgh, Pennsylvania. This greatly expanded the number of clear evenings available for working on this project.

In retrospect, I have learned a lot about the lives of William and Caroline Herschel, along with the objects that they discovered. While there are a number of nice large, bright objects including galaxies, star clusters, and nebulae, the majority of Herschel's objects are small, faint, dim smudges of galaxies. It gives you an appreciation for the brighter Messier objects. Still, there is a wide variety of shapes and sizes of interesting deep-sky objects for any type of telescope. I now have a much greater respect for all those faint fuzzies and the work of the Herschels. I encourage everyone to get out tonight and try your hand at finding and observing the deep-sky objects of William and Caroline Herschel! ✶

Larry McHenry is a member of Kiski Astronomers and Oil Region Astronomical Society in western Pennsylvania. His website is www.stellar-journeys.org

ASTRONOMICAL LEAGUE ORIGINS AND HISTORY

By Chuck Allen

The Astronomical League will celebrate its diamond anniversary in 2021. In the 75 years since its founding, the League has grown to become the largest astronomy organization in the world (with the exception of the Planetary Society, although they're focused more on space exploration). As we near this significant anniversary, I thought it might be fun to share the story of the League's birth.

Edward Halbach, co-founder and first elected president of the Astronomical League (1947-48). (Courtesy Milwaukee Astronomical Society)

The first meaningful attempt to organize amateur societies occurred in 1935 when Edward Halbach and Luverne Armfield of Milwaukee cobbled together a dozen midwestern clubs to form the Amateur Astronomical Association. Its constituents were linked by a common newsletter. At meetings of AAVSO (the American Association of Variable Star Observers) during that period, Halbach came to know the famous Dr. Harlow Shapley, director of Harvard College Observatory. Recognizing the significant role played by amateur astronomers in public education and astronomical discovery, Shapley avidly supported this midwestern effort to form a national amateur organization. His friendship with Ed Halbach would later prove important.

Luverne Armfield, co-founder of the Astronomical League. (Courtesy Milwaukee Astronomical Society)

Meanwhile, a similar plan was hatching in the east. A group called the Amateur Astronomers Association of New York organized a three-week exhibition at the 1939 New York World's Fair, an event that attracted the interest of Charles A. Federer, Jr., editor of *The Sky* magazine (later *Sky & Telescope*). The last two days were reserved for an amateur convention and, despite drenching rain, over 300 people, including Shapley, attended. On the second day, August 20, 1939, organizational meetings were held with a view toward developing a national body of amateur astronomers. Federer took an informal leadership role, and the group agreed to reconvene at Pittsburgh's Buhl Planetarium the following summer.

The 1940 Pittsburgh meeting featured an "Astronomical Widows" group to occupy the wives of what were, at that time, predominantly male delegates. Federer was named chair of the committee on permanent organization and was the first person to refer to the nascent body as a "league." Once again, their work could not be completed in the time allotted.

Charles A. Federer, Jr., co-founder and 33-year editor of Sky & Telescope magazine and co-founder of the Astronomical League. (Courtesy Sky & Telescope).

Meetings of this eastern group resumed in July 1941 at Washington's famous inauguration hotel, the Willard, but **the "Astronomical Widows" vanished. Female delegates chose instead to participate in substantive meetings** and, in so doing, gained for themselves prominent and critical leadership roles early in League history. After years of constitutional wordsmithing, the "Amateur Astronomers' League of America" (AALA) was set to commence operation upon ratification by ten societies. By the last week of November 1941, twelve societies had ratified, and the newborn organization accepted Margaret Back's offer to hold the first AALA convention in Detroit in 1942.

But on December 7, 1941, the world changed. The proposed 1942 Detroit meeting was scrubbed due to gas rationing, and the AALA vanished in the fog of war.

At war's end, however, Margaret Back and the Detroit and Warren Astronomical Societies reprised their eastern group's Detroit convention plan and arranged a 1946 meeting at the Cranbrook Institute of Science in Bloomfield Hills. This convention location was critical. To understand why, recall that two groups had attempted formation of a broader national society – Ed Halbach's midwestern association and Charles Federer's eastern organization. The opportunity to merge the two groups at a location central to both gave strength to the effort, and both entities had a friend in Harlow Shapley.

Harlow Shapley, Harvard College Observatory astronomer and first interim president of the Astronomical League (1947). (Public Domain photo, Wikipedia)

Meeting together in Bloomfield Hills, the two groups decided to jointly renegotiate the eastern group's 1941 AALA constitution, and Federer reopened the committee on permanent organization to draft a new one. The new document set dues at 15 cents per year ($2 in today's dollars), changed the body's name to "Amateur Astronomers League," and, rather oddly, rejected a controversial anti-astrology provision. As in 1941, the League was, by the terms of its newly revised charter, to commence operation upon ratification by ten societies.

The Astronomical Society of Maine (Portland) provided the tenth signature on November 15, 1946. On that date, the Amateur Astronomers League was born, rising phoenix-like from the ashes of war...this time to stay.

On July 4, 1947, the first official Amateur Astronomers League convention opened at Philadelphia's Franklin Institute with Harlow Shapley serving as interim president. There the League elected permanent officers, and Shapley's friend from AAVSO days, Ed Halbach of the midwestern group, became its first elected president. (The eastern group would get its shot at the top with the election of Helen Federer as League president one year later.) Two other important decisions were reached at that first convention in 1947. Charles Federer proposed the regional structure still in use by the League today, and the delegates decided to change the name of the organization one last time, to the Astronomical League. By the time members left Philadelphia, the League claimed 1,568 members in 31 societies and had $67.52 in its treasury ($780 in today's dollars).

Helen S. Federer grinding a telescope mirror in the 1930s. She was co-founder of Sky & Telescope magazine and second elected president of the League (1948-49). (Courtesy Sky & Telescope)

Mabel Sterns incorporated the League under Washington, D.C., law in January 1948 and went to work with Grace Scholz (later Spitz) to create a League newsletter. By September, a four-page mimeographed *Bulletin* was mailed to each club and at-large member. Seven years later, in 1955, the *Bulletin* was renamed the *Reflector*, and the council voted to send it to every individual member of League clubs. The copy you're reading now is the product of that vote two-thirds of a century ago.

Today, your League boasts 18,310 members and 304 member societies. It hosts the most comprehensive set of observing programs in the world, having issued more than 16,000 certificates to members completing over 80 different observing regimens. It maintains a Library Telescope program, the beautiful quarterly *Reflector* magazine, a national office in Kansas City, a comprehensive website, League Sales, extensive youth award programs with prizes, a new International Region, and well-planned conventions – sometimes featuring eclipses and cruises! From those fledgling efforts in the 1930s and 1940s has arisen a truly valuable organization. To those in the deep past who cobbled it all together, and to all of you who have helped it flourish since, well done. But despite our success, we must remember the admonition of the Romans: *sic transit gloria mundi* (all glory is fleeting).

In 1993, Princeton astrophysicist, best-selling author, and 1998 Astronomical League Award winner, J. Richard Gott, wrote a paper outlining what he calls his delta-t argument, which was strongly championed in William Poundstone's recent book, *The Doomsday Calculation*. The delta-t argument suggests that, with 50 percent certainty, the Astronomical League will last at least 25, but not more than 225, more years. Essentially, it's the idea that, assuming we do not occupy a special position as observers, our celebration of the League at this 75th anniversary has a 50 percent chance of occurring in the middle 50 percent of the League's ultimate timeline. In other words, there's a 50 percent chance that we will last at least one-third as long, and not more than three times as long, as we have in the past.

Delta-t should sound an alarm, for it is not unexpected that a 75-year-old organization might fail in as little as 25 years. For this reason, we must constantly strive to update, advance, and improve the League, expand beyond our borders, improve and market our services, seek grants, and, most importantly, attract a younger and more diverse membership.

So, let's use this anniversary celebration to anticipate the new challenges that amateur astronomy will face in the future and find new and innovative solutions to those challenges. And never, ever, underestimate the difference that you or your club can make. One good idea is all it takes. Remember, also, that astronomy is unique in that there are fewer than 6,000 professional astronomers in all of North America, far too few to meet the vast public demand for astronomy education. Just as Dr. Shapley did 75 years ago, professional astronomers today recognize the critical role that amateur astronomers play in meeting that public demand. That's why the Astronomical League is vital, not only to the hobby, but to the science itself.

By merely joining the League, you become part of a network of friends and relationships that will soon span the globe. You create a link between amateurs and professionals. You give amateur astronomy a voice with which to address travesties like light pollution and commercial billboards in space. You provide a structure for national youth awards and national publicity for your members and fellow amateurs. You establish a legitimizing organization for master-level achievements. You support Library Telescope programs that can attract younger members. And you link the League with related amateur organizations. So, to all of you who are part of the League family, thank you for all you have done over these past 75 years. Let's make the next 75 even better! ✷

First official League convention, Franklin Institute, Philadelphia, Pennsylvania, July 4-6, 1947. Hosts: Amateur Astronomers of the Franklin Institute, Rittenhouse Astronomical Society. (League archive)

Everest of the Sky

THE ULTIMATE OBSERVING CHALLENGE: THE HUBBLE DEEP FIELD

By Dave Tosteson

Over my observing career I've been fortunate to have had the opportunity, equipment, and conditions to see many wondrous objects. Inspiration came from mentors early on, and from hearing world-class researchers explain their lifework. As I look back, there are highlights such as seeing brown dwarfs, gravitational lenses, and quasar light nearly as old as the Big Bang. But one target stands above the rest for not only its challenge, but its importance to humanity's collective understanding of the size and complexity of our Universe. A quarter century ago, in an instant, its image made our Cosmos forever more compelling. For astronomers, the Hubble Deep Field was like opening a newly found door to explore unimagined space. For me, it was a touchstone of vision.

From my very first look through a telescope in 1985 I was thrilled to experience the *realness* of seeing things so beautiful or distant with my own eyes. Knowing that their light had traveled for what seemed an immeasurable amount of time, and that they were available for me to view whenever I opened my telescope, were powerful motivators. I wanted to learn about and see as much as I could about the heavens. Aperture fever quickly drove me to get an 18-inch instrument to replace my original 10-inch. A few years later I upgraded to a 25-inch reflector after being exposed to the deepest of arcane objects at the Texas Star Party (TSP). My late friend Barbara Wilson, along with her observing partner Larry Mitchell, were constantly showing interested parties things like Hoag's Object, peculiar Arp galaxy pairs, and Gomez's Hamburger. I couldn't get enough. Wilson was also charged with scheduling evening speakers for the star party and, in 1995, would invite the most significant and inspiring quartet of her career.

Paul Hickson was a young astronomer from Vancouver who had studied compact galaxy groups and published a list of one hundred of them in 1982. Timothy Ferris was a writer and journalist from Berkeley, best known for his PBS series on the evolution of the Universe, and his book *Galaxies*. Halton Arp studied under Edwin Hubble and became famous for finding 338 individual and groups of unusual galaxies on the Palomar plates and publishing them in his seminal 1966 *Atlas of Peculiar Galaxies*. As if this lineup weren't enough, she induced Robert Williams, the director of the Space Telescope Science Institute, to come to the west Texas mountains to enlighten us about events and plans for the newly refurbished Hubble Space Telescope (HST).

Hubble was launched in April 1990 and everyone quickly saw that its images were blurred by spherical aberration in the primary mirror. This was a multi-billion-dollar mistake, and an extreme embarrassment to the team who built it. An optical repair (COSTAR, the Corrective Optics Space Telescope Axial Replacement) was designed, built, and flawlessly carried out by shuttle astronauts in December 1993. Williams was a spectroscopist by training, having worked in the Chilean Andes among other places. As director, he could allocate ten percent of Hubble's precious time to any project he chose. He proposed to use the telescope to stare at a previously blank area of the sky for a very long time, just to see what was there.

The Hubble Deep Field from 1995. Credit: R. Williams (STScI), the Hubble Deep Field Team and NASA

Many colleagues thought this was a bad idea. If nothing were found, it would have been another blow to the agency, possibly bringing calls to defund the telescope. Despite the chance of failure, Williams was resolute. As quoted in *National Geographic*, he said "Scientific discovery requires risk. If it's that bad, I'll resign. I'll fall on my sword." But his decision paid off, rewarding both the team that carried it out and all humanity with an image that is Hubble's most iconic for astronomers.

The criteria for picking an area to image were that it be somewhere devoid of any bright objects, have a high galactic latitude away from obscuring Milky Way dust, and a location within Hubble's continuous viewing zones – celestial circumpolar swaths where the telescope could look at any time, even when its orbit was out of Earth's shadow. From December 18 to 28, 1995, HST took 342 images in four wavelengths, totaling one hundred hours of imaging. Processing took about two weeks, and the result was revealed at an American Astronomical Society meeting on January 15, 1996. Over three thousand galaxies were found in that tiny area of sky (2.7 arcminutes on a side) just off the Big Dipper's handle. Small fragments of thirtieth-magnitude, misshapen protogalaxies could be seen in this *Hubble Deep Field* (HDF) to within a couple billion years after the Big Bang. The number of estimated galaxies in the Universe quintupled overnight, to fifty billion. The project captured the imagination of not only professionals but the public as well, including an amateur interested in viewing it for himself.

The excitement from the 1995 TSP had motivated me to take my observing to a new level, and projects to view all of Arp's and Hickson's groups were well underway in the spring of 1996. To most efficiently use my time under such dark and southerly skies, my practice was to spend several months before a star party preparing charts and targets to observe. My first exposure to the HDF was *Sky & Telescope's* May 1996 article, published just a month before the star party. In that pre-Internet age, I could plot the HDF coordinates on a star charting map, but there was little context around it in the way of stars or images for reference. It sat about six degrees north of Eta and Delta Ursae Majoris, forming a slightly offset tall triangle with them, and was 42 arcminutes northwest of the eleventh-magnitude spiral NGC 4605. At the 1996 Texas Star Party I had no wider images for comparison, and magnitudes were not available for objects within the field, so I just did not know whether they were possible to see.

I spent 40 minutes viewing the Deep Field using my 25-inch telescope at 661 power while hand guiding atop my ladder, made a drawing, and put it away. What chance could anyone have of viewing objects in such a faint and distant field? These observations languished for a long time, but as I was preparing a talk for our local astronomy society about two years later I revisited them. By then the Hawaii group had done photometry on many of the principal galaxies for their "Active Catalog of the HDF." Wider images were now available to help orient the field around the HDF to help me determine what I had seen. To my great astonishment, as I reviewed my drawing, two objects in the Deep Field were represented! I was unable to reproduce the observation from my home in Minnesota, and the next time this field could be observed from a very dark site had to wait until the 2004 Texas Star Party.

At that event using my 25-inch scope the star #2/galaxy #3 and galaxy #0 were seen in the HDF after prolonged, careful searching. The latter is the brightest galaxy in the Deep Field at magnitude 18.9 (602 nm), and it was certainly star #2 that was seen, as galaxy #3 is magnitude 21.8.

That same night Bob Summerfield of *Astronomy to Go* was using his 36-inch Tectron reflector, and was almost ready to call it a night at 2 a.m. I wandered over and inquired if he wanted to attempt one more field. Initial reluctance was transformed to anticipation with mention of the HDF, and we used that wonderful instrument to get the best view I have had of this area. We spent many minutes viewing it and Bob, David Moody, and I were able to confirm a number of galaxies in the field. I saw a total of six galaxies (four within the HDF and two just outside it), plus two stars. The ones inside the HDF corresponded to the Hawaii numbering system of galaxies #0 and #6, along with stars #1 and #2, and two unnumbered galaxies at the northern and southwest edges of the field. There were also galaxies seen just beyond the southwest edge of the field and to the northeast of the galaxy at the northern edge. There were clearly many galaxies seen, and this view superseded all previous attempts in my 25-inch. Follow-up observations in another 36-inch telescope that same night 45–60 minutes later, and in Jimi Lowrey's 48-inch scope several years later, could not reproduce the clarity of that best view. Jimi, Tim Parson, and I saw only two or three galaxies in the larger 48-inch scope, showing that sky conditions are key to viewing such faint objects. I feel we were extremely fortunate on that early morning of May 22, 2004, to observe the Deep Field under such superb conditions. ✷

Only those who will risk
Going too far
Can possibly find out
How far they can go

–T.S. Eliot

DATA ON HDF AREA OBJECTS. NUMBERS ARE FROM THE HAWAII ACTIVE CATALOG (HAC); THEY ARE GALAXIES UNLESS OTHERWISE SPECIFIED; MAGNITUDES FROM HAC ARE AT 602 NM; OTHERS ARE FROM MEGASTAR; "~" INDICATES MY VISUAL ESTIMATES.

OBJECT	MAGNITUDE	RIGHT ASCENSION	DECLINATION
0	19.0	12h 36m 49.33s	+62d 13m 47.81s
1 (star)	20.2	12 36 54.65	62 13 29.07
2 (star)	19.6	12 36 54.26	62 12 42.35
3	21.8	12 36 56.56	62 12 46.84
6	20.4	12 36 51.00	62 13 21.56
galaxy off NE corner of HDF	~19.0	12 36 54.4	62 14 52
galaxy at SW corner of HDF	20.1	12 36 41.8	62 11 34
galaxy W off SW corner of HDF	18.2	12 36 36.9	62 11 35.5
star E off SE corner of HDF	14.5	12 37 09.5	62 12 34.1
galaxy on N border of HDF	~20.2	12 36 48.34	62 14 26.9

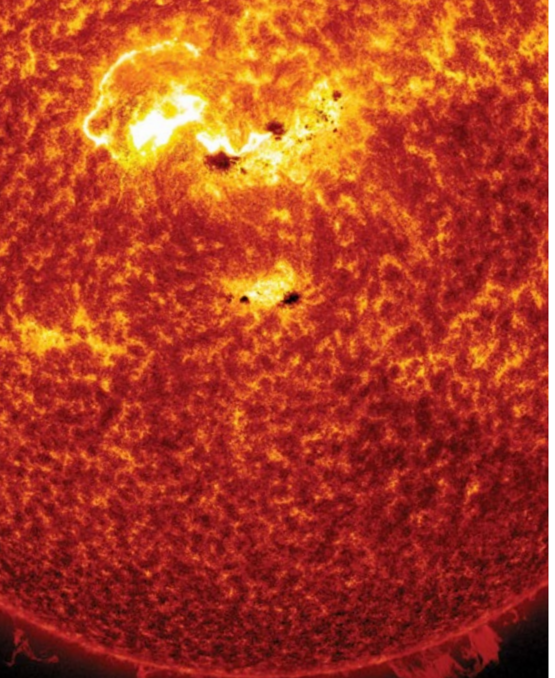


IMAGE CREDIT: NASA, CELEST HOANG

GEAR UP FOR SOLAR CYCLE 25

SAFETY FIRST

EVERY POTENTIAL OBSERVER OF THE SUN ***MUST*** UNDERSTAND THAT ANYONE LOOKING AT THE SUN THROUGH AN OPTICAL INSTRUMENT, ***EVEN FOR THE SHORTEST AMOUNT OF TIME***, WILL FOREVER DAMAGE THEIR EYES ***UNLESS*** PROPER FILTRATION GREATLY LIMITS THE AMOUNT AND WAVELENGTHS OF LIGHT PASSED THROUGH THE INSTRUMENT! EVEN LOOKING DIRECTLY AT THE SUN WITH YOUR NAKED EYES CAN CAUSE PERMANENT DAMAGE TO YOUR EYESIGHT. ***SO DON'T DO IT.***

by Jamey L. Jenkins

Solar observers since Heinrich Schwabe in 1847 have known that the Sun goes through periodic activity cycles. The waxing and waning of sunspots, taking approximately 11 years from one minimum to the next, is a standard indication of solar activity. During solar maximum, the Sun's disk can be peppered with dozens of spots, while at minimum, as we are now experiencing, few to no spots can be the norm.

Astronomers have identified these fluctuating cycles back to the time of Galileo, although the official numbering of cycles begins with the minimum of 1755. The latest, Solar Cycle 24, is ending, while Cycle 25 is just emerging. These two rhythms will overlap until spots from the old cycle fade completely and the spots of the new cycle remain.

EMERGING CYCLE 25

Solar Cycle 24 made its appearance near the end of 2008 creating an unusual "double peak" in 2011 and 2014. Thereafter, Cycle 24 has steadily diminished with Cycle 25 making an appearance in mid-2019. Predictions for upcoming solar activity have been similar to Cycle 24. While sounding disheartening, remember that forecasting is a new science and unexpected eruptions occur frequently! That is what's wonderful about solar astronomy; you never really know what you will see from day to day.

For the amateur astronomer, our Sun offers a unique opportunity to explore an average star from our own backyard. Observing the Sun now, during solar minimum, and then following it in the coming months and years is a sure-fire way to learn about solar physics and the behavior of stars. If you are on a shoestring budget, no outrageously expensive telescopic accessories are necessary. White-light observing, viewing the Sun (safely) in the wavelengths at which we normally see it in the sky, is inexpensive and serves as an introductory activity into the world of daytime astronomy. For the uninitiated, this is an invitation to "come out of the dark" and experience the Solar System's most dynamic body, the Sun.

SAFEST WAYS TO OBSERVE THE SUN IN WHITE LIGHT

There are two safe ways to observe the Sun in white light. The first was practiced by early astronomers and still remains a modest means of seeing evolving features on the Sun's disk. This method is called **solar projection,** in which the Sun is viewed indirectly, as an image projected by a telescope's eyepiece onto a white screen. More recently, solar projection was superseded by another technique utilizing a special, yet inexpensive, filter at the entrance of the telescope; we call this **direct observation.**

SOLAR PROJECTION

In a nutshell, solar projection is best accomplished with a device known as the "Hossfield Pyramid." Named after the former chair of the Solar Division of AAVSO, the American Association of Variable Star Observers, the screen is a pyramid-shaped box constructed of sturdy cardboard or thin wood (figure 1). The small end of the pyramid is attached to a projection eyepiece and the viewing screen (usually matte white paper) is located at the base of the pyramid. The inside of the box is painted flat black, and an opening on one side allows an observer to see the projection screen clearly. When attached to a refractor's star diagonal, the open side of the pyramid is always in the shade, providing a bright view of solar features. Note: compound telescopes such as Schmidt- or Maksutov-Cassegrains should never be used for projection due to heat damaging the internal components.

Figure 1. Hossfield Pyramid constructed of black foam board with a Bristol board projection screen. When used in this position, with a star diagonal, the screen is always in the shade, permitting bright, contrasty views of the Sun.

Figure 2. Pre-mounted Baader visual filter attached to a 10-inch Schmidt-Cassegrain telescope; nylon screws hold the filter securely in place.

The distance between the eyepiece and viewing screen is determined by the desired size of the projected solar disk, the focal length of the telescope, and the focal length of the projecting eyepiece. Begin by calculating the size of the Sun (in millimeters, for example) at the prime focus of your telescope by multiplying the focal length of your telescope (also in millimeters) by 0.0093. Now determine the projection magnification needed to obtain a desired solar diameter by dividing the desired size by the size of the prime focus Sun you just calculated. Normally a projection diameter of 150 mm is sufficient. Finally, multiply the magnification needed by the focal length of a particular eyepiece to determine the necessary distance between the eyepiece and the projection screen. For example: a telescope with a focal length of 600 mm will produce an image of the Sun at prime focus that is 600 mm × 0.0093, or 5.6 mm, across. Projecting an image of the Sun that is 150 mm in diameter using this telescope requires a magnification of 150 mm ÷ 5.6 mm = 27. Using an eyepiece with a 10 mm focal length, then, the projection screen needs to be 27 × 10 mm, or 270 mm, from the eyepiece.

Use inexpensive eyepieces for projection. Avoid eyepiece designs that use cement between the elements. Optical cement can melt from the heat of the Sun near the focal plane of a telescope, destroying the eyepiece. The older Ramsden and Huygens designs are ideal for solar projection.

DIRECT OBSERVATION

Another safe and considerably superior method of white-light solar observing is the direct viewing technique. The direct view provides greater contrast than the projected image, as well as being sharper and more detailed. Direct observation is accomplished by adding a special filter to the entrance (aperture) of the telescope that removes infrared and ultraviolet light while reducing the Sun's overall visible brightness to a safe level. This filter is called an objective filter and is sold by many astronomy dealers in a variety of models.

Of all the visual objective filter products available, the Baader Astrosolar Film density 5.0 is an excellent option. Baader also markets a lower-density (3.8) filter for imaging; be sure to obtain the 5.0, which is intended for visual observing. The Baader filter transmits a neutral-colored view with minimal distortion of the Sun's light that passes through it. The filter material is reasonably priced and is available mounted, ready to use on a telescope (figure 2), or as a single sheet for crafty observers wishing to mount it themselves.

Certain eyepiece color filters can be used to enhance solar features when used with a Baader objective filter. Amateur observers will find the most useful colors to be blue, green, and red. A blue filter enhances the appearance of faculae located far from the solar limb. A green filter improves the contrast of faculae/granulation, and a red filter augments sunspot umbrae while improving seeing conditions a bit. For visual work I prefer the lighter shades of these filters. **Important: these colored eyepiece filters are used *in addition* to the solar filter that limits the light entering your telescope.** Decades ago, "eyepiece solar filters" were distributed with some inexpensive refractors; these were inherently unsafe and caused blindness when they failed. Needless to say, if you come across one at a tag sale it should never be used.

Lastly, the Sun can be centered in the telescope by watching the telescope's shadow on the ground. When the shadow is smallest, the Sun is centered in the telescope. Alternatively, a special solar finder can be purchased to attach in place of the regular optical finder on the telescope. **Never look through a standard finder to locate the Sun; in fact, it's best to cover or remove it from the telescope when observing the Sun to prevent accidents.**

WHAT TO SEE IN WHITE LIGHT

Observing the Sun during solar minimum can be challenging, but encouraging at the same time. We have recently experienced weeklong periods of inactivity only to be surprised by a Cycle 25 sunspot emerging from behind the east limb. In other words, you never know for sure what will happen from day to day on the Sun.

As you observe the face of the Sun in white light, you will notice darker patches on the visible surface or photosphere. These are *sunspots,* the most obvious feature of the white-light Sun. Sunspots result from magnetic fields generated by the rotation of the Sun and the boiling motions of convection in the Sun's outer layers. Through these motions, creation of electrical currents gives birth to the magnetic fields, which evolve further through a repeating cycle of stronger currents and magnetism. Eventually, a field is powerful enough to emerge on the surface with its pocket of gas and become what is known as an *active region.*

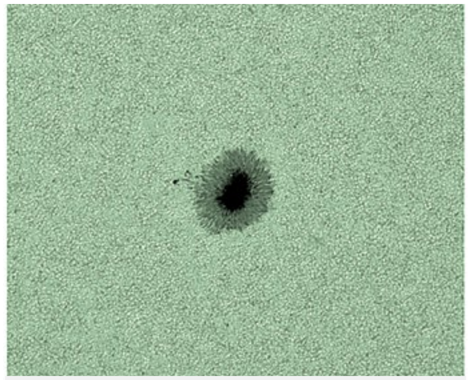


Figure 3. Symmetrical sunspot imaged at medium resolution through a 5-inch f/18 refractor with a Baader objective filter and green supplementary filter. The fine structure of the penumbra and surface granulation are just visible. All images provided by the author.

Larger spots are composed of a darker center called the *umbra* surrounded by a less-dark *penumbra.* If seeing is unusually good, you may see that the penumbra is composed of many dark hairlike *penumbral filaments* radiating outward from the umbra with brighter *penumbral grains* trapped between them. Individual sunspots occasionally are crossed by bright streaks called *light bridges.*

Notice that sunspots tend to cluster into bunches known as sunspot groups. Sunspot groups are classified according to their characteristics by the McIntosh classification system. This three-letter system describes a group's stage of development and can indicate that it might produce flares.

The entire solar disk is covered by a mottled surface known as *granulation.* Some cells of this granulation may be filled in, but not as darkly as the umbra of a sunspot. The larger dark cells are called *pores.* Surrounding sunspot groups, especially visible near the solar limb, are bright venous streaks named *faculae.* Occasionally a facular region will be bright enough to be seen well into the disk, but this is rare. All sunspot groups are associated with faculae, but the opposite is not the case. Faculae can exist without the presence of a sunspot group, as is the case with *polar faculae;* however, sunspots are never seen farther from the solar equator than heliographic latitude 50 degrees.

OBSERVING WITH A PURPOSE

Solar observing can create a sense of excitement when the telescope is pointed sunward. All events happening on the Sun are unique, never repeated exactly. For the novice astronomer I recommend locating and establishing contact with other observers through organizations such as the Association of Lunar and Planetary Observers (ALPO), AAVSO, or the British Astronomical Association (BAA). Most local clubs also have a few members who are avid viewers of the Sun; seek them out for advice and guidance.

It is possible for the dedicated solar observer to participate in several "citizen scientist" programs that add to databases of knowledge about our local star. The ALPO Solar Section accepts observations (drawings, images, or sunspot counts) for inclusion in their online archives. ALPO observations extend back to the establishment of the section. The AAVSO solar division maintains a database of Wolf sunspot numbers and also monitors solar activity via sudden ionospheric disturbances. The Astronomical League also has goal-oriented solar observing programs: the Sunspotter Observing Program and the Hydrogen Alpha Solar Observer Program. ✷

Jamey Jenkins is a member of the Twin City Amateur Astronomers.

HELPFUL LINKS:

alpo-astronomy.org/solarblog
aavso.org/solar
britastro.org/section_front/21
astroleague.org/observing.html

Our Expedition to See the Northern Lights

By John Strebeck and Lynne Lang

Among the most awesome of celestial displays, the northern lights, or aurora borealis, are mesmerizing for their spectacular waving curtains of colorful light. With observing auroras on our bucket lists, we journeyed north to Fairbanks, Alaska, for this purpose. Nighttime temperatures hovered at a shivering –20°F during the last week of February, but despite the frigid weather, forecasts predicted optimal chances of observing an aurora. Along with dark, nearly moonless skies, we also had the good fortune of four cloud-free nights.

TYPES OF AURORA
(with increasing energy levels)
HOMOGENEOUS ARC
RAYED ARC
RISING VAPOR COLUMN
CORONA

Each night at about 10 p.m. the display began as a greenish band of light low along the northern horizon (the "homogeneous arc"). As the evening progressed, the display became more energetic. Curtains and streamers were common in the middle of the night until around 2–3 a.m. The third night provided a spectacular display, as luminous shafts of light climbed high in the sky, even on occasion projecting directly overhead. The rays, shapes, and curtains during this energetic phase were changing on time frames of five seconds or less. Pulses of bright spots were moving rapidly across the sky, horizon to horizon, leaving very bright arcs. In total, we saw three of the four types of aurora, with "corona," the most energetic, being the only type we did not see.

The experience exceeded our expectations. We stargazed at times from inside our cozy Airbnb that had several large windows facing north, located 17 miles north of the city. We found the University of Alaska website invaluable for northern lights insights, predictions, and science *(www.gi.alaska.edu/monitors/aurora-forecast).*

Lynne captured these scenes using a Nikon D7000 camera (15–30 mm zoom lens, f/2.8, ISO 4000–6000 for 4–5 second exposures). The photos revealed even more structure and depth than was visible to our eyes. Although the green color dominated the aurora, we did see tones of red, purple, and blue faintly at times, and photographs captured these well. ✷

Homogeneous arc aurora (note: printed reproduction cannot capture all the colors visible in Lynne's photos)

Rayed arc aurora

Rising vapor column aurora

GALLERY

MEMBER ASTROPHOTOGRAPHS

George Lutch (Fort Worth Astronomical Society) captured this image of the Cygnus Wall using an Explore Scientific FCD100 ED127 with a ZWO ASI1600GT camera.

GALLERY

MEMBER ASTROPHOTOGRAPHS

Above: Andrew Klinger (North Texas Astronomical Society) captured this image of Comet C/2020 F3 (NEOWISE) from Fort Griffin State Historic Site in Texas using a William Optics GT81 (reduced to f/4.7 – 382 mm) with a ZWO ASI1600MM-Cool CMOS camera.

Below: Rob Kirkham (member-at-large) created this image of star trails and fireflies from five hundred 15-second exposures using a Canon 6D camera with a Rokinon 14 mm lens at f/2.8.

Left:

Ed LaBelle (Psalm 19 Astronomy Society) made this drawing of the Moon from Cedar Park, Texas, based on an image taken with an Orion ED80T CF with a Celestron 8x24 zoom at 8 mm.

Below:

Jeff Lepp (Houston Astronomical Society and Fort Bend Astronomy Club) captured this deep, wide-field image of NGC 7023 using Takahashi FSQ-106EDX IV with a ZWO ASI294MC Pro camera.

ROYAL ASTRONOMICAL SOCIETY OF CANADA

SPECIAL PRICES ON RASC OBSERVERS' RESOURCES!

OBSERVER'S HANDBOOK

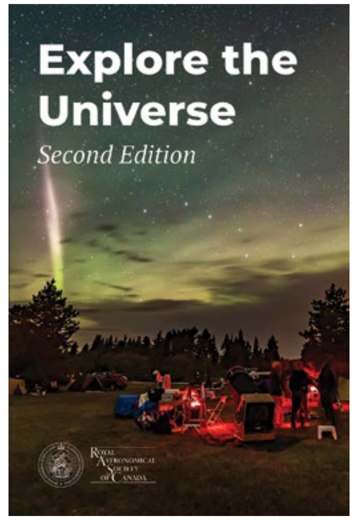
The popular 350–page classic in its 113th Year. Special pricing for 2021 USA edition! Contents include • Basic Astro Data • Planets • Optics and Observing • The Sky Month by Month • Eclipses • The Moon • Time (civil, astronomical, standards, & more) • The Sun • Dwarf and Minor Planets • Meteors, Comets, and Dust • Stars • The Deep Sky

$24 EACH + $4.50 S+H
ORDERS OF 12 OR MORE:
$23 EACH WITH FREE SHIPPING!

EXPLORE THE UNIVERSE GUIDE

A PERFECT GUIDE FOR THOSE LEARNING THEIR WAY AROUND THE NIGHT SKY

$20 PLUS $4.50 S+H



STAR FINDER

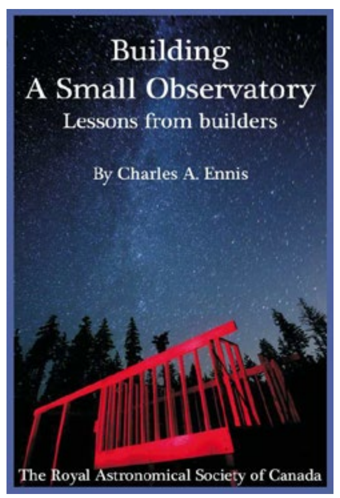
DISCOVER THE NIGHT SKY WITH THIS AFFORDABLE, EASY TO USE COMPACT PLANISPHERE

$2 PLUS $1 S+H

OBSERVER'S CALENDAR

A beautiful complement to the Handbook, filled with dates of notable celestial events – lunar and planetary conjunctions, eclipses, meteor showers and more.

$18 EACH + $6 S+H
ORDERS OF 12 OR MORE: $17 EACH WITH FREE SHIPPING!



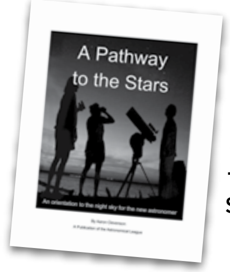
BUILDING A SMALL OBSERVATORY

This book is the result of interviews with 140 small observatory owners to learn what it takes to fund, build, and operate a small observatory. It will help you maximize your chances of successfully creating a trouble-free installation, and help find the best site and equipment.

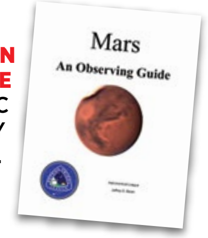
$20 PLUS $5.50 S+H

SECURE ONLINE ORDERING FROM
STORE.ASTROLEAGUE.ORG
Or order by mail at Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114. Enclose check for price and S+H charges as shown. Questions? Call 816-DEEPSKY or email leaguesales@astroleague.org

ASTRONOMY HOLIDAY SHOPPING

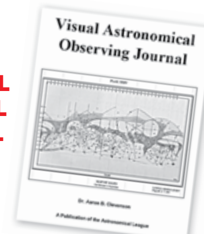


A PATHWAY TO THE STARS
THIS MANUAL IS A GREAT INTRODUCTION TO ASTRONOMY FOR THE NEW ASTRONOMER.
$10 PLUS $4 S&H



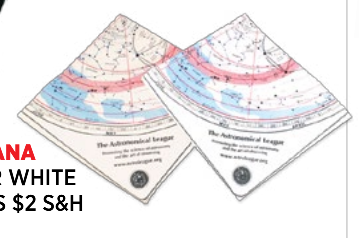
MARS – AN OBSERVING GUIDE
A SYSTEMATIC PROGRAM STUDY OF THE RED PLANET.
$18 PLUS $6 S&H

PLANETARY NEBULAE
$19 PLUS $6 S&H



ASTRONOMICAL LEAGUE VISUAL ASTRONOMICAL OBSERVING JOURNAL
$16 PLUS $6 S&H

ASTRONOMICAL LEAGUE TRAVEL MUG
$10 PLUS $4.50 S&H



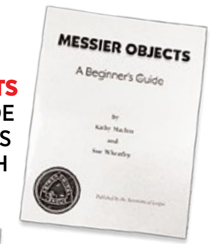
ASTRONOMICAL LEAGUE BANDANA
NATURAL OR WHITE
$13 PLUS $2 S&H

ASTRONOMICAL LEAGUE WINTER KNIT CAP
NAVY/GRAY, PURPLE, BLACK, MAROON, ROYAL BLUE; $20 PLUS $5 S&H

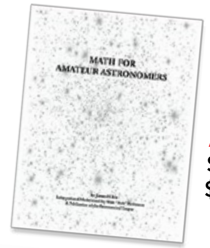
ASTRONOMICAL LEAGUE BASEBALL HAT
EMBROIDERED LOGO, ADJUSTABLE; ROYAL BLUE, MAROON, KHAKI, NAVY; $18 PLUS $5 S&H

ASTRONOMICAL LEAGUE SPORTSMAN'S BUCKET HAT
EMBROIDERED LOGO, ONE SIZE; KHAKI ONLY
$22 PLUS $5 S&H

UNIVERSE SAMPLER
A JOURNEY THROUGH THE UNIVERSE FOR THE BEGINNER
$13 PLUS $5 S&H



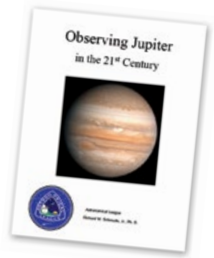
MESSIER OBJECTS
A BEGINNER'S GUIDE
$8 PLUS $3 S&H



MATH FOR AMATEUR ASTRONOMERS
$14 PLUS $5 S&H

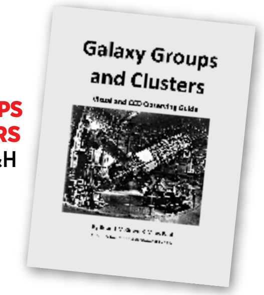
ASTRONOMICAL LEAGUE TOTE BAGS
NYLON (LEFT) OR CANVAS
$12 PLUS $6 S&H

CARBON STARS
A GUIDE TO THE CARBON STAR OBSERVING CLUB
$12 PLUS $4 S&H

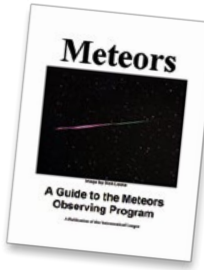


OBSERVING JUPITER IN THE 21ST CENTURY
$12 PLUS $4 S&H

THE HERSCHEL II OBSERVING PROGRAM
$18, PLUS $7 S&H

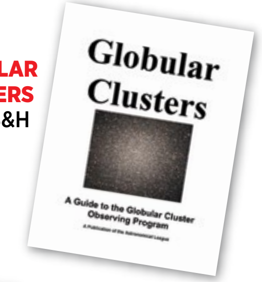


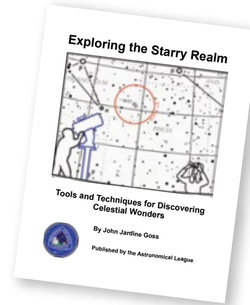
GALAXY GROUPS AND CLUSTERS
$20 PLUS $7 S&H



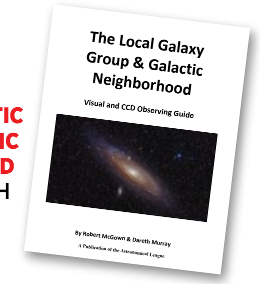
METEORS—
A GUIDE TO THE METEORSOBSERVING PROGRAM
$11 PLUS $4 S&H

GLOBULAR CLUSTERS
$14 PLUS $5 S&H





EXPLORING THE STARRY REALM
TOOLS AND TECHNIQUES FOR DISCOVERING CELESTIAL WONDERS
$14 PLUS $5 S&H



THE LOCAL GALACTIC GROUP & GALACTIC NEIGHBORHOOD
$23 PLUS $8 S&H

HERSCHEL 400
NOW REVISED AND EXPANDED
$15 PLUS $5 S&H

SECURE ONLINE ORDERING FROM
STORE.ASTROLEAGUE.ORG
Or order by mail at Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114. Enclose check for price and S+H charges as shown.

Observing Awards

Advanced Binocular Double Star Observing Program
No. 35, **Rodney Rynearson**, St. Louis Astronomical Society

Alternate Constellations Observing Program
No. 1, **Brad Young**, Astronomy Club of Tulsa

Arp Peculiar Galaxies Northern Observing Program
No. 99-V, **Alfred Schovanez III**, Astronomical Society of Eastern Missouri; No. 100-I, **Marie Lott**, Atlanta Astronomy Club

Asterism Observing Program
No. 61, **Stephen L. Snider**, Albuquerque Astronomical Society; No. 62, **Brad Payne**, Northern Virginia Astronomy Club

Asteroid Observing Program
No. 58, **István Mátis**, Regular, Member-at-Large; No. 59, **Jim Chenard**, Regular, Member-at-Large

Beyond Polaris Observing Program
No. 40, **Salil Kulkarni**, Houston Astronomical Society

Binocular Double Star Program
No. 158, **Mark Bailey**, Member-at-Large; No. 159, **José Bosch Bailach**, Member-at-Large; No. 160, **Michael Titus**, Cincinnati Astronomical Society; No. 161, **John Zimitsch**, Minnesota Astronomical Society; No. 162, **Ryan Behrends**, Hill Country Astronomers; No. 163, **Jeffrey S. Moorhouse**, La Crosse Area Astronomical Society; No. 164, **Jason Brandt Dodson**, NASA Skywatchers Astronomy Club; No. 165, **Jeffrey Hiscock**, Member-at-Large

Binocular Messier Observing Program
No. 1198, **John Galla**, Astronomical Society of Eastern Missouri; No. 1199, **Richard Wheeler**, Northeast Florida Astronomical Society; No. 1200, **Michael Grabner**, Rose City Astronomers; No. 1201, **Shawn Grant**, Knoxville Observers; No. 1202, **Jim Hontas**, Cincinnati Astronomical Society

Bright Nebula Observing Program
No. 20, **Jim Chenard**, Basic, Member-at-Large; No. 21, **Brad Payne**, Advanced, Northern Virginia Astronomical League; No. 22, **W. Maynard Pittendreigh**, Advanced, Lifetime Member

Caldwell Observing Program
SILVER AWARDS
No. 271, **István Mátis**, Member-at-Large; No. 272, **Gus Gomez**, Tucson Amateur Astronomy Association

Carbon Star Observing Program
No. 114, **Terry Trees**, Amateur Astronomer Association of Pittsburgh; No. 115, **Alfred Schovanez III**, Astronomical Society of Eastern Missouri; No. 116, **Eric Rachut**, Central Texas Astronomical Society; No. 117, **Antone G. Gregory**, Minnesota Astronomical Society

Citizen Science Observing Program
No. 1, **Dan Crowson**, Astronomical Society of Eastern Missouri, Supernova Hunters, Active Gold Class 3; No. 1, **Al Lamperti**, Delaware Valley Amateur Astronomers, Galaxy Zoo Star Notes, Active Gold Class 9; No. 1, **Al Lamperti**, Delaware Valley Amateur Astronomers, Mapping Historic Skies, Active Silver; No. 1, **Russell F. Pinizzotto**, Southern Maine Astronomers, Galaxy Zoo, Active Silver

Comet Observing Program
No. 47, **Jeff Hoffmeister**, Gold, Olympic Astronomical Society; No. 48, **David Whalen**, Gold, Atlanta Astronomy Club; No. 49, **Rodney Rynearson**, Gold, St. Louis Astronomical Society; No. 113, **Robert Harrison**, Silver, Patron-Member-at-Large; No. 114, **Alfred Schovanez III**, Silver, Astronomical Society of Eastern Missouri; No. 115, **Rodney Rynearson**, Silver, St. Louis Astronomical Society; No. 116, **Jody Raney**, Silver, Shreveport Bossier Astronomical Society

Constellation Hunter Northern Skies Observing Program
No. 250, **Aaron Roman**, Kalamazoo Astronomical Society; No. 251, **Mike Titus**, Cincinnati Astronomical Society

Dark Nebulae Observing Program
No. 30 and 30-I, **Martin Griffiths**, Member-at-Large; No. 31, **W. Maynard Pittendreigh**, Lifetime Member; No. 32, **Kevin C. Carr**, Minnesota Astronomical Society

Deep Sky Binocular Observing Program
No. 417, **Jean Napp**, Iowa County Astronomers; No. 418, **Darin Templet**, Rio Rancho Astronomical Society

Double Star Observing Program
No. 656, **Richard Wheeler**, Northeast Florida Astronomical Society; No. 657, **Michael A. Pascavage**, Delaware Valley Amateur Astronomers; No. 658, **Charles Fry**, Astronomy Enthusiasts of Lancaster County; No. 659, **Hans de Moor**, Member-at-Large; No. 660, **Don Gazdik**, Minnesota Astronomical Society

Flat Galaxy Observing Program
No. 26-I, Honorary, **W. Maynard Pittendreigh**, Lifetime Member

Galaxy Groups and Clusters Observing Program
No. 47-DA/I, **Jack Fitzmier**, Member-at-Large

Galileo's T.O.E.S. Observing Program
No. 2, **Scott G. Kranz**, Astronomical Society of Kansas City

Globular Cluster Observing Program
No. 348-I, **Steve Boerner**, Member-at-Large; No. 349-I, **Jeffrey Padell**, Skyscrapers, Inc; No. 350-V, **Mark Bailey**, Member-at-Large; No. 351-V, **Brian McGuinness**, Northern Colorado Astronomical Society; No. 352-V, **Tom Wilson**, Atlanta Astronomy Club; No. 353-V, **Sean Smith**, Denver Astronomical Society; No. 354-V, **Kathryn McCallum**, Houston Astronomical Society; No. 355-V, **Matt Orsie**, Tri-State Astronomers; No. 356-V, **Steven Powell**, Houston Astronomical Society

Herschel Society Observing Program
No. 12, **Dan Crowson**, Silver, Astronomical Society of Eastern Missouri; No. 13, **Ron Abbot**, Silver, Astronomical Society of Kansas City

Hydrogen Alpha Solar Observing Program
No. 48, **Joseph Novosel**, Fort Wayne Astronomical Society; No. 49, **Terry Trees**, Amateur Astronomers Association of Pittsburgh

Library Telescope Observing Program
No. 1, **Marc Stowbridge**, Silver and Gold, New Hampshire Astronomical Society; No. 2, **Donald Ficken**, Silver and Gold, St. Louis Astronomical Society; No. 3, **W. Maynard Pittendreigh**, Silver, Lifetime Member; No. 4, **Chuck Simms**, Silver and Gold, Astronomical Society of Eastern Missouri; No. 5, **Robert Togni**, Silver and Gold, Central Arkansas Astronomical Society; No. 6, **Amy E. White**, Silver, Astronomical Society of Eastern Missouri; No. 7, **James Zappa**, Silver, Member-at-Large; No. 8, **Cook Feldman**, Silver and Gold, St. Louis Astronomical Society

Local Galaxy Group & Neighborhood Observing Program
No. 46-M, **David Wickholm**, San Antonio Astronomical Association; No. 47-M, **Matthew Orsie**, Tri-State Astronomers

Lunar I Observing Program
No. 1107-B, **Robert Togni**, Central Arkansas Astronomical Society; No. 1108, **James Cantu**, Smoky Mountain Astronomical Society; No. 1109-B, **W. Maynard Pittendreigh**, Lifetime Member; No. 1110-B, **Charles E. Allen III**, Evansville Astronomical Society; No. 1111, **James L. Twellman**, Astronomical Society of Eastern Missouri; No. 1112, **Jennifer Siders**, Tri-Valley Stargazers; No. 1113, **Michael Phelps**, Atlanta Astronomy Club; No. 1114, **Yu-Hang Kuo**, Seattle Astronomical Society; No. 1115 and 1115-B, **Patrick McNeil**, Member-at-Large; No. 1116 and 1116-B, **John Lilly**, Boise Astronomical Society; No. 1117 and 1117-B, **Eric Edwards**, Albuquerque Astronomical Society; No. 1118 and 1118-B, **Don Gazdik**, Minnesota Astronomical Society; No. 1119 and 1119-B, **Kevin Carroll**, Member-at-Large

Lunar II Observing Program
No. 110, **Mark Bailey**, Member-at-Large; No. 111, **Bradley Nasset**, Minnesota Astronomical Society; No. 112, **Scott Cadwallader**, Baton Rouge Astronomical Society

Lunar Evolution Program
No. 1, **Robert Togni**, Central Arkansas Astronomical Society; No. 2, **Albert Lamperti**, Delaware Valley Amateur Astronomers; No. 3-I, **Aaron Clevenson**, North Houston Astronomy Club; No. 4, **Charles E. Allen III**, Evansville Astronomical Society; No. 5, **Brad Young**, Astronomy Club of Tulsa; No. 6-I, **W. Maynard Pittendreigh**, Lifetime Member; No. 7-I, **Mark Simonson**, Everett Astronomical Society

Messier Observing Program
No. 2810, **Sam Finn**, Honorary, Central Pennsylvania Observers; No. 2826, **Johnney Ehrlich**, Honorary, Mason Star Gazers; No. 2835, **Richard DeMidio**, Regular, New Hampshire Astronomical Society; No. 2836, **Eric E. Edwards**, Regular, Albuquerque Astronomical Society; No. 2837, **Michael Grabner**, Honorary, Rose City Astronomers; No. 2838, **Richard Wheeler**, Honorary, Northeast Florida Astronomical Society; No. 2839, **Ryan Schaefer**, Honorary, Boise Astronomical Society; No. 2840, **Dave Decker**, Regular, San Diego Astronomy Association; No. 2841, **Trena Johnson**, Regular, Minnesota Astronomical Society

Meteor Observing Program
No. 76, **Steven Sauerwein**, 24 hours, Member-at-Large; No. 191, **Gregory T. Shanos**, 12 hours, Museum Astronomical Resource Society; No. 195, **Andrea L. McCann**, Honorary, Member-at-Large; No. 196, **Glenn Wolford**, 12 hours, Member-at-Large; No. 199, **Rob Ratkowski**, Honorary, Haleakala Amateur Astronomers; No. 201, **Jeff Willson**, 6 hours, Rose City Astronomers

Nova Observing Program
No. 9, **Al Lamperti**, Silver, Delaware Valley Amateur Astronomers

Outreach Observing Award
No. 1213-O, **Venkatesh Narayan**, Fort Bend Astronomy Club; No. 1215-O, **Arnav Narayan**, Fort Bend Astronomy Club; No. 1216-O, **Stephen Hyde**, Fort Bend Astronomy Club; No. 1217-O, **Bill Castro**, Central Florida Astronomical Society; No. 1217-S, **Bill Castro**, Central Florida Astronomical Society

Planetary Nebula Observing Program
No. 1, **W. Maynard Pittendreigh**, Advanced Southern Imaging, Lifetime Member; No. 13, **John Sayers**, Advanced Imaging, Member-at-Large; No. 14, **Jack Fitzmier**, Advanced Imaging, Member-at-Large; No. 15, **W. Maynard Pittendreigh**, Advanced Imaging, Lifetime Member; No. 39, **Sam Finn**, Basic, Central Pennsylvania Observers

Radio Astronomy Observing Program
No. 28-B, **Brad Payne**, Northern Virginia Astronomy Club

Sky Puppy Observing Program
No. 64, **Christopher Toenjes**, Kansas Astronomical Observers; No. 65, **Gianna Buck**, Bartlesville Astronomical Society; No. 66, **Andrew Pu**, Bartlesville Astronomical Society

Sketching Observing Award
No. 41, **Dick Francini**, Neville Public Museum Astronomical Society

Solar System Observing Program
No. 159, **Gerald Jones**, Minnesota Astronomical Society; No. 160-B, **Rodney Rynearson**, St. Louis Astronomical Society; No. 161-B, **W. Maynard Pittendreigh**, Lifetime Member; No. 162, **Alan Scott**, Albuquerque Astronomical Society; No. 163 and 163-B, **Antone Gregory**, Minnesota Astronomical Society; No. 164, **Daniel Boggs**, Albuquerque Astronomical Society; No. 165, **Eric Edwards**, Albuquerque Astronomical Society

Southern Sky Binocular Observing Program
No. 103, **W. Maynard Pittendreigh**, Lifetime Member

Southern Sky Telescopic Observing Program
No. 60, **Jonathan L. Schuchardt**, Rio Rancho Astronomical Society; No. 61, **John Canaday**, Rio Rancho Astronomical Society

Two in the View Observing Program
No. 40, **Antone Gregory**, Minnesota Astronomical Society; No. 41, **Alfred Schovanez**, Astronomical Society of Eastern Missouri

Urban Observing Program
No. 208, **Michael Grabner**, Rose City Astronomers

Universe Sampler Observing Program
No. 147, **David P. Rudeen**, Telescope, Etna Astros; No. 148, **John Strebeck**, Telescope, St. Louis Astronomical Society

Variable Star Observing Program
No. 39, **Paul Harrington**, Member-at-Large

Master Observer Progression
OBSERVER AWARD
David Wilkholm, San Antonio Astronomical Association; **Gerard Jones**, Minnesota Astronomical Society; **Antone G. Gregory**, Minnesota Astronomical Society; **Dan Beggs**, Albuquerque Astronomical Society; **James Zappa**, Member-at-Large; **John Strebeck**, St. Louis Astronomical Society
MASTER OBSERVER AWARD
No. 239, **Steve Goldberg**, Houston Astronomical Society; **James L. Twellman**, Astronomical Society of Eastern Missouri
ADVANCED OBSERVER AWARD
Mark Bailey, Member-at-Large
MASTER OBSERVER AWARD – SILVER
Mark Bailey, Member-at-Large
BINOCULAR MASTER OBSERVER
Rodney Rynearson, St. Louis Astronomical Society; **Antone G. Gregory**, Minnesota Astronomical Society

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

NON-PROFIT
ORGANIZATION
U.S. POSTAGE
PAID
TUCSON, AZ
PERMIT #271