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Reflector

A FOCUS ON MEMBER ACTIVITIES AND EXPERIENCES

Contents

James Daley *(Springfield Telescope Makers) captured this image of a Solar prominence with his homemade 106 mm f/21.2 Lyot coronagraph, using a ZWO ASI1600MM CMOS camera. The image was further processed by* Reflector *staff to adjust curves for print quality, remove dust specks, and extend the background at top and bottom to fit our cover format. Watch for an article by Mr. Daley about this remarkable instrument in an upcoming issue.*

Reflector

The Astronomical League Magazine

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A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION
To promote the science of astronomy
• by fostering astronomical education,
• by providing incentives for astronomical observation and research, and
• by assisting communication among amateur astronomical societies.

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Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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***REFLECTOR* AND CLUB ROSTER DEADLINES**

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

LETTERS TO THE EDITOR
Send to *larsen@ccsu.edu* with subject line "letter to editor"

To the Editor

The Sprouls' excellent article on the Gaia catalog brings a whimsical thought. All of the sky we see is the celestial sphere, looking down the past light cone, to great distances and to the past proportionately. But one can define an anti-celestial sphere, which is all the objects in the sky where and when hypothetical observers in the sky see us, but with ourselves at the center.

A crude map could be made by advancing stars in position by proper motion based on their light travel times doubled. What might such a map be good for? It might be useful for those SETI researchers who are sending signals out in hopes of a reply some distant day.

As I said, a whimsical thought.

—Francis Graham
East Pittsburgh, Pennslyvania

"The New Andromeda"—another mind-boggling concept of the universe written up by Dave Tosteson! Is he ever going to run out of universal (pun intended) ideas?

There is a tiny error in the September 2022 *Reflector*, page 24, left column, paragraph 2, line 12: al-Rhaman should be al-Rahman ("[of] the Merciful").

More phonetic Arabic is 'Abd ar-Raḥmān aṣ-Ṣūfī, "servant/slave of the Merciful, the Sufi," just to be persnickety on my part.

So we are almost ready for the coming Milkomeda collision, far too soon!

—Carl Masthay
Retired medical editor, linguist, Algonquianist, amateur astronomer, 81, Creve Coeur (St. Louis), Missouri

Star Beams

This quarter ended with a most satisfying experience for your traveling president. In late September, League First Lady Betty Iorg and I were honored to join the Minnesota Astronomy Society (MAS) in celebrating their 50-year anniversary. Their can-do attitude was repeatedly referenced during the anniversary celebrations. The incredible number of astronomical observing sites and facilities the club has developed over the years is a powerful example of this positive attitude. It should be noted that past Astronomical League president James Fox was a major influence in the early, formative days of the society.

They have been blessed with innumerable contributions of telescopes and related astronomical equipment, spanning the range from personal entry-level instruments to state-of-the-art professional equipment. This generosity did not just happen by accident. The underlying positive and inclusive attitudes that we experienced during our visit dovetail nicely with the feedback we received from the President's Panel Discussion at ALCon 2022. Diversity and inclusion are never-ending challenges and opportunities for our clubs and members, but the MAS has made good progress in this regard.

We were struck by the strong and welcoming attitude during our many interactions during our three-day stay from the members – from the current president, Mark Job, and immediate past president, David Falkner, to the entire membership who turned out in strong measure for the celebration and related observing site celebrations. MAS hosted a successful ALCon 2018, with one of our best-attended and best-organized events.

For example, the second night we were in the Minneapolis area we visited the club's newest collaboration with another group. This is the periodic star party and program at the Cedar Creek Ecosystem Science Reserve. An added bonus was helping the society celebrate Fall Astronomy Day on its official date, October 1, at the Eagle Lake Observatory complex. As the League and our sponsors of Astronomy Day are planning to breathe new life into the Astronomy Day program, it was refreshing to see in action the high quality of organization the club exhibited. In addition to various astronomical displays, the planners again expended the time and effort necessary to set up the ingenious Apollo 11 Lunar Module that the club constructed a few years ago and

displays occasionally. It's a very realistic model, with attention to faithfully duplicating the looks and dimensions of the original, and precise placements of related parts of the display such as the positions of various instruments. Also, the MAS incorporated the International Observe the Moon Night program information into the Astronomy Day activities.

—Carroll Iorg
President

International Dark-Sky Association

THE ECONOMIC IMPACT OF LIGHT POLLUTION

Light pollution has a big impact on amateur and professional astronomers. From our perspective it is one of the most important issues the world faces. However, it certainly pales in comparison to the war raging in Ukraine, the threat of famine, terrible flooding or drought in many places, plus the continued suffering from widespread diseases like malaria and tuberculosis. Nonetheless, the economic effect of light pollution on wasted energy and money spent for light going into the sky is not trivial. On the IDA website there is an interesting summary of these effects: "Light is Energy: Estimating the Impact of Light Pollution on Climate Change" *(darksky.org/light-is-energy-estimating-the-impact-of-light-pollution-on-climate-change)*.

This provides a good overview of the economic impact of poor outdoor nighttime lighting. In this column I present some of the interesting statistics from the IDA article, but I recommend you read the entire article and look at its references. It is estimated all light emission worldwide as seen on the classic satellite image of the world at night is equivalent to one percent of all global greenhouse gas emissions. Any light seen by a satellite orbiting above the Earth is wasted. Even light on the ground from the sources sending light directly up into space may be wasted. Prime examples of this waste are a lit, empty parking lot at 3 a.m. or sports lighting left on all night at a small park where there is no action after 10 p.m.

One of the best monitors of light pollution is the Visible Infrared Imaging Radiometer Suite (VIIRS) *(nesdis.noaa.gov/current-satellite-missions/currently-flying/joint-polar-satellite-system/jpss-mission-and-2)*. This instrument collects images of the Earth in visible and infrared wavelengths, observing the land, atmosphere, cryosphere, and oceans. It is currently flying on the Suomi National Polar-Orbiting Partnership (NPP) and NOAA-20 satellite missions, giving daily images across multiple electromagnetic spectral bands. It is responsible for the Earth at Night's Black Marble image *(nesdis.noaa.gov/s3/2021-08/Earth-at-Night_CARD.png)*. While its main function is to monitor the Earth for a wide range of functions such as improving forecasting for weather, flooding, and storms, it also provides the most widely used set of images for looking at light pollution.

Light escaping upward has two main sources. There is direct emission of light into the sky by poorly designed luminaires, and then there is light reflected off the ground and going up into the sky. Properly designed lighting can reduce direct light emission into the sky to a minimum, but reflection off the ground is more difficult to control. This is mainly kept in check by making sure a nighttime light is actually needed, the amount of light emitted is proper for the task at hand, and the light is turned off or reduced in intensity when not needed.

IDA estimates we spend at least $50 billion a year worldwide in energy costs producing light that escapes into space. We used to say 35 percent of outdoor light is wasted, which costs at least $3 billion in the United States annually. There has been a widespread transition to more energy-efficient LED (light-emitting diode) lighting fixtures, but, unfortunately, there is probably a rebound effect whereby as light becomes cheaper, more of it is used. We may, therefore, be wasting as much energy as previously or even more. How the recent economic effect of increasing inflation will change our use of lighting remains to be seen.

A more detailed discussion on the IDA webpage indicates the economic costs may be substantially greater than first stated. The estimates are based on the images from the VIIRS. This shows only a portion of the spectrum of light emitted into the sky and underestimates the total energy lost into space by light pollution. It also doesn't account for any unnecessary lighting on the ground.

The United States Department of Energy regularly reports on lighting. Its 2022 Solid State Lighting Report notes that 40 percent savings are possible using smart controls on outdoor lighting. This involves dimming and turning off lights when not needed. In the future such controls may even turn on streetlights ahead of a vehicle moving down a dark lane and off after the vehicle has passed by. Smart controls could theoretically save $3.4 billion a year in light costs in the United States by 2035 if there were 75 percent market penetration.

These numbers are not very solid, but they do give one a sense of what can be done to save money and help the sky. It is also noted that many municipalities tend to use lighting at many times the recommended levels. There was a very successful LED streetlight conversion in Tucson, Arizona. The conversion was carefully planned and coordinated by professional lighting experts. Tucson reduced its light emissions by 7 percent and realized an annual savings of $2.16 million.

—Tim Hunter
Co-founder IDA

Night Sky Network

SPEAKERS FOR YOUR CLUB MEETINGS?

Does your club host speakers for your events? Finding speakers for your meetings can be challenging for many reasons. Is your club in a more isolated region of the country? Does your club meet at odd times or in remote areas? Is the prospect of asking potential speakers intimidating? Fear not, as we have a few tips to help you land a choice speaker for your members! →

FINDING SPEAKERS: LOOK WITHIN

Your club may already have great speakers! Ask your club members about their own experiences and passions. Perhaps there is an engineer in your midst who worked on amazing NASA missions, a talented and enthusiastic astrophotographer who wants to share their latest masterwork and how it was made, a top contributor to a notable citizen science project, or someone who knows a huge amount about myriad astronomical topics. Maybe someone wants to share their astronomy tourism experiences, or has a friend of note visiting the area. Ask to see if any of them would be interested in presenting. Clubs often find that many of their most memorable speakers are their own members. This shouldn't be too surprising; after all, you're a group of people gathered together to share a common interest!

FINDING SPEAKERS: LOOK AROUND

Are there any regular astronomy or science talks in your area? Check out local colleges, schools, nature centers, and museums for inspiration. Attend science cafes and guest lectures, special science events at local parks and libraries, and pay attention to astronomy guests on local radio and TV news shows to search possible new speakers, as well as for your own entertainment and education. Of course, also make sure to check out the meetings of neighboring astronomy clubs and regional star parties! College and graduate students in particular love to present their research, not to mention postdocs and professors. Approach the speakers afterwards and see if they would be interested in speaking to your club; you'd be delighted to find out how many folks would love to! Even if the speaker can't present, for whatever reason, they can often recommend other potential speakers from their own professional circles. At the very worst, you've gotten to check out more fun events in your area and maybe learned a thing or two in the process. And of course, checking out how other organizations run their events can provide inspiration for your own club's events.

Historian Bill Moore presents on "Oklahomans and Space" at a meeting of the Oklahoma City Astronomical Society. Credit: David Huntz

FINDING SPEAKERS: LOOK FAR

You may be lucky and live next to a NASA center, a college with an astronomy or physics program, or even a famous observatory, full of potential guest speakers! While many clubs don't have that luxury, you would be surprised to find just how many astronomers and scientists work remotely. You may find out there is an amazing potential speaker near you after all, or someone willing to travel. Your area may seem isolated, but might be a convenient spot for folks visiting nearby locales, or that have seasonal tourism – perhaps even astro-tourism! If your club is lucky enough to have a budget for events, you could even potentially pay for travel and a honorarium for their time – but your officers may wish to reserve that for very special occasions, like an award ceremony or anniversary event. At any rate, go for the gold! Did you hear an amazing speaker on the radio or a podcast, or love one person's appearance on a popular science program? It never hurts to reach out and ask! Even if they can't speak to your club, as mentioned previously, they may know another potentially excellent astronomy speaker who may be available, or may even offer to present to your club via a virtual platform. This brings us to another potential option: online presentations!

Project engineer Robert Verb presents on the development of the James Webb Space Telescope at a meeting of the Lima Astronomical Society. Credit: Michael Ritchie

FINDING SPEAKERS: ONLINE

Your club may still be holding meetings online-only, or via a hybrid setup. In that case, you have a variety of speaker options as travel is not an issue. In this case, location still matters, as time zones are important, so make sure to keep track of the time difference when planning, and have a practice session in advance if folks would like to have a tech check. Many clubs, even very small ones, discovered this fact during the pandemic and have hosted many notable speakers as part of their online speaker series. While taste for online meetings and presentations has waned due to "Zoom burnout" and the like, virtual presentations are still a great alternative for many clubs. Keep your options open!

SPEAKER CANCELLATIONS: BACKUP PLANS

Sometimes your speaker can't make it, and you find out the day of – if not minutes before! What to do? Always have a backup plan. Maybe you have that one amazing club member with a fun imaging project or new telescope they've built; keep them on tap as a possible substitute, along with a couple other members, as a backup speaker pool. Keep a backup presentation handy, just in case. The Night Sky Network has a collection of customizable presentations just for this sort of situation, and you can download them at *bit.ly/nsnpresentations.* You can also keep a copy of a good documentary or science fiction movie handy to fill the time in case of emergencies, too. Just check the contents first to ensure it's appropriate for your audiences – memory can be a poor guide. An essential part of event planning is to plan for the worst while hoping for the best, and if you have a backup plan, you'll be well prepared.

You may have noticed the real key to finding speakers is nonstop communication and networking; keeping your eyes and ears open, following what seems interesting or unique, and then just asking. You would be amazed at how many people say "yes" if you just ask! So go out, be bold and curious, and ask away, even if it seems intimidating; your members will thank you later!

—David Prosper

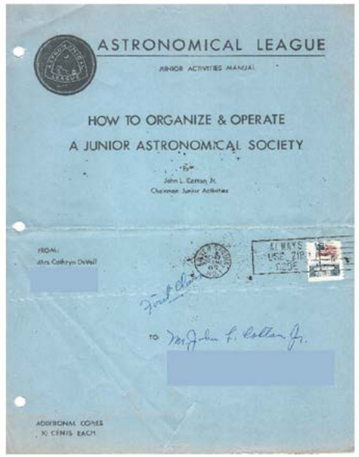
Full STEAM Ahead

STILL THE WORLD'S OLDEST JUNIOR ASTRONOMER

(CONTINUED FROM LAST ISSUE)

The Junior Activities Committee chair, John Cotton, Jr., was pivotal in the continuing support of the junior astronomers that were joining the Astronomical League. Of course, John was not operating on his own, but in concert with the League's leadership, which was committed to this end. In the mid to late 1960s, John took the booklet described in part one of this story and updated it. The original book was assembled in the early 1960s by the students of the Louisville Astronomical Society with the help of their sponsor. This was the gold standard, assembled by students who desired to learn about a science that was not widely offered at high schools.

There was a perfect storm, with lunar missions and space probes keeping the youth engaged in getting any information that they could glean. It reminds me of those movies starring Mickey Rooney and Judy Garland where youth wanted to do something, they passionately collaborated, and boom! – you had a musical. Young people worked together and even kept each other going when the adults weren't so supportive. Substitute the phrase "junior astronomy club" for "musical" and that describes what happened in youth astronomy in the 1960s.



John mentioned how students came together and were writing papers, generating newsletters, forming astronomy clubs, making home movies, creating models, assembling slide shows, and giving talks at every turn. Through the work of John and others on the Junior Activities Committee, the League created a book service for students, generated the observing manual for the Messier objects, created three levels of certificates: beginner, where no telescope was required, and intermediate and advanced levels that represented further mastery in observing.

In 1968, John arranged for the junior astronomers to have their own separate meeting session at the national convention where they could brainstorm with their peers. Newsletters were exchanged and new concepts sprang forth. A discussion took place in 1972 in the National Jr. News Notes, the national junior astronomer newsletter, sharing how these students wanted to become science reporters in their own right on various observational phenomena. They did not want to simply repeat data from the adults, but wanted to conduct proficient research. The students would be encouraged to pursue their own topics of interest, proceed at their own speed, and be able to become members of ALPO, AMS, and AAVSO based on their own work. With the support of John and the League, these students worked their way into the scientific communities.

Mr. Cotton stated how many of his students went on to have careers in the science of astronomy and physics. He said, "it's funny how these students, now in their 60s, are retiring from their life's work, and me in my 80s." He added, "these are friends for life, and we have stayed in touch all these years." He also noted that the students of today are different from his retiring students, as the cell phone has been accused of doing a disservice to the current student population. He would love to still engage youth on a more regular basis, but being the loving husband that he is, he has other priorities now.

The truth is, John was one key leader, but there are countless others who have inspired students to go above and beyond their wildest dreams. In fact, some of these former students are in the leadership of the League, while others are doing great things in keeping their historic old clubs relevant today. It would make for a very interesting list to see the estimated number of students who grew up in the League's Junior Astronomer Activities Programs, but that is a project for another day.

—Peggy Walker
Astronomical League STEAM and Junior Activities Coordinator

Wanderers in the Neighborhood

THE MYSTERY OF PLANET NINE

The planet count in our Solar System increased by one with the discovery of Pluto in 1930. Since its average distance from the Sun is more than that of Neptune's 2.8 billion miles (30.1 Astronomical Units, AU), Pluto was the first trans-Neptunian object (TNO) to be discovered. The planet count dropped back to eight when Pluto was redesignated a dwarf planet in 2012. But astronomers are hunting for another planet in the far reaches of the Sun's family that may bring the count back to nine.

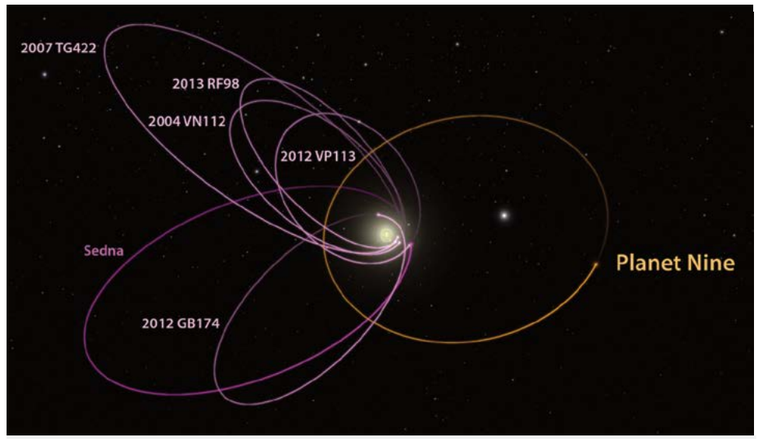
The region beyond Neptune is divided into three bands. The inner band is the Kuiper Belt, a torus of icy bodies in nearly circular orbits that extends from Neptune outward to around five billion miles (55 AU) from the Sun. This doughnut-shaped region is aligned with the plane of the ecliptic and it is the source of short-period comets. The next band is the scattered belt objects, composed of Kuiper Belt Objects (KBOs) that have been thrown out of the Kuiper Belt by the gravity of the major planets, especially Neptune. Their highly elliptical orbits now take them far beyond the Kuiper Belt and away from the ecliptic, but they always come back near Neptune's orbit.

The final band is the Oort Cloud, which is much further away. It stretches from around two hundred billion miles (2,000 AU) from the Sun out to one-third of the way to the nearest star. The Oort Cloud is not constrained to the ecliptic, but surrounds the Solar System like a giant bubble. It is also composed of icy bodies, which, when they get knocked out of their orbits and fall toward the Sun, becoming the long-period comets. All of these groups are trans-Neptunian objects.

The extremely distant TNOs (ETNOs) exist beyond the Kuiper Belt, averaging between fourteen and nineteen billion miles from the Sun (150 to 200 AU). These objects are difficult to discover because the Sun's light is very dim at this distance causing them to be very faint. In addition, they move very slowly against the background stars. This is important, because objects in our Solar System are discovered by looking for their motion over time. Whether an object is a planet, comet, or moon, it orbits a local body (usually the Sun or a planet). As it moves in its orbit, images of it will show that motion against the stationary background stars. This is a standard technique which first "discovered" the naked-eye planets.

The immense distance from the Sun causes the ETNOs to move very slowly relative to this background. Their orbital periods range from three thousand to almost one hundred thousand years. The slow apparent motion requires a search area to be imaged and then reimaged much later to detect the object's slow relative motion. In addition, long exposure times are needed to record these dimly-lit objects, reducing the area that can be searched even more.

ETNOs are brightest when they are near perihelion, the point in their orbits that is closest to the Sun. They are also moving the fastest at that point. This is where most of these objects have been discovered. Even at their brightest, they are between magnitude 21 and 25. As they move outward in their orbit, they become even fainter and slower, making them harder to discover. It is therefore not known how many ETNOs are in the



The six most distant known objects in the Solar System all have their perihelia in the same region of the ecliptic and are tilted in the same direction. Planet Nine's presumed perihelion is on the other side of the Sun. This location allowed Planet Nine's gravity to wrangle the orbits of the other six extreme trans-Neptunian objects into a common configuration. Planet Nine's gravity may have also tilted the orbits of the other eight planets six degrees away from the plane of the Sun's equator. Image Credit: JPL-Caltech: R. Hurt (IPAC)

outer Solar System.

Only thirty-eight of these objects have been discovered. In 2014, astronomers Chadwick A. Trujillo and Scott S. Sheppard noted that all thirteen ETNOs known at that time had a similar orbital parameter called the *argument of perihelion,* a measure of the angle between the point of perihelion and where the body's orbit crosses the plane of the Earth's orbit (the ecliptic). They suggested that there might be a small planet in the outer Solar System coaxing these objects into similar orbits.

A similar phenomenon is the gaps in Saturn's rings, generated by tiny "shepherding" moons embedded in the rings. Ring particles in the gap ahead of a moon are slowed down by the moon's gravity, causing them to move into lower orbits. Particles behind the moon are pulled toward it. This accelerates them into higher orbits. In both cases, the particles are thrown out of the gap, keeping it clear.

ETNOs are too distant to be much affected by Neptune or the other planets, so the gravity of an unseen planet in the outer Solar System would be free to shepherd the orbits of the ETNOs. Over many thousands of years, it would cause the orbits to slowly align. Caltech professor Mike Brown found the problem interesting and took it down the hall to theoretician Konstantin Batygin. Together they developed models of ETNO orbits and how they would be affected by a planet in deep space.

Their analysis showed the six most distant objects are in elliptical orbits that are aligned in the same direction. If there was nothing to alter their orbits, they should be randomly oriented. They also noticed that the inclinations of these six ETNOs were also aligned. They were all tilted about thirty degrees downward relative to the plane of the ecliptic. To find these six objects to be so aligned is highly unlikely without something to cause their orbits to shift.

While an unseen planet could cause the orbits to align, there were other prospective perturbers. They modeled and discarded many other possibilities. The model that best fit the observations was a planet with a mass of ten Earths that had a perihelion on the opposite side of the Sun from the perihelia of the aligned ETNOs. It would have to be twenty times farther from the Sun than Neptune, roughly fifty-six billion miles (600 AU). They dubbed this massive planet "Planet Nine."

This model also explained the orbits of the dwarf planet 90377 Sedna and the minor planet 2012 VP_{113}, which had been kicked out of the Kuiper Belt by Neptune, but no longer traveled down near it. Planet Nine had reshaped the orbits of these two objects raising their perihelia so they no longer traveled down near Neptune's orbit. The model generated a probability map of the region where Planet Nine may be located, but not its precise location. The highest probability is near the planet's aphelion, roughly in the direction of the constellation Taurus.

Amateur astronomers can participate in the search for Planet Nine. The Zooniverse Catalina Outer Solar System Survey and the Zooniverse SkyMapper Planet 9 projects are both out of data, but may get more in the future. The Zooniverse Backyard Worlds project *(zooniverse.org/projects/marckuchner/backyard-worlds-planet-9)* uses archival data from the Wide-field Infrared Survey Explorer (WISE) spacecraft. Each field is represented by four images that are "blinked" in sequence. Any moving object, like Planet Nine, will appear as a moving dot. Only thirteen percent of the available images have been examined so far. There is plenty of opportunity for citizen scientists to participate in the first planetary discovery in 176 years.

—Berton Stevens

Deep-Sky Objects

JEWELS IN THE CROW'S NEST

Some of the best galactic star clusters visible during the winter lie along the Milky Way in the constellations Canis Major and Puppis. Canis Major is easy to find because the constellation contains Sirius, the brightest star in the night sky. In clear dark skies, the Milky Way is readily visible on the east side of Sirius. The constellation Puppis borders Canis Major on the east and south sides. The constellation is much larger than Canis Major and spans twice the distance in the north-south direction. All of Puppis is visible from south of 35 degrees north latitude. Those in the northern half of the contiguous 48 states are still able to see a majority of the star clusters in Puppis when the constellation transits during clear winter nights.

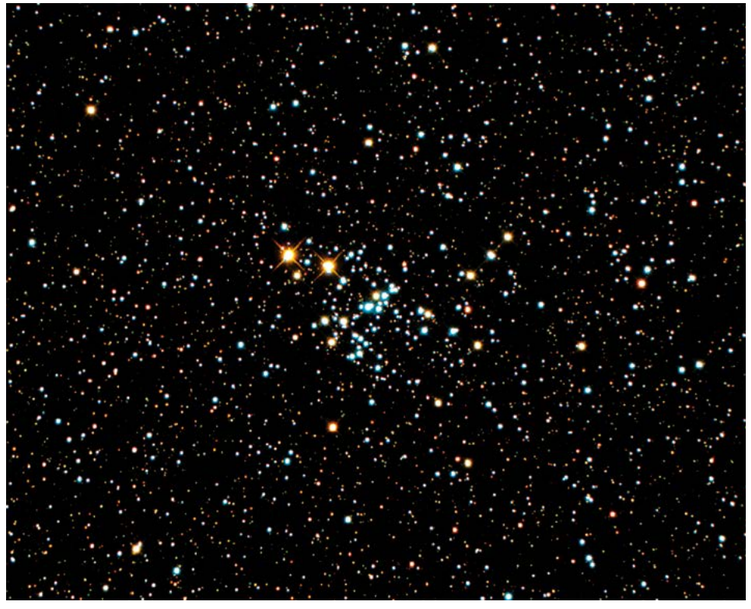
Canis Major is the big dog, in mythology, one of two hunting dogs associated with Orion. The other hunting dog is depicted as the constellation Canis Minor. Both dogs follow Orion across the sky as the constellations rise in the east and set in the west.

The constellation Puppis has a more convoluted history than Canis Major. The constellation was originally part of a much larger constellation known as Argo Navis (the Ship Argo). In mythology Argo was the ship built by Argus and was used by Jason and the Argonauts (of which one was Argus) as they searched for the Golden Fleece.

Some astronomers thought that Argo Navis was too large a constellation. It was 28 percent larger than the next largest constellation and contained more than 160 naked-eye stars. Therefore in 1755, the French astronomer Nicolas Louis de Lacaille broke Argo Navis into three ship parts: Carina (the keel), Puppis (the poop deck) and Vela (the sails). He also added the constellation Pyxis (the ship's compass). In breaking up Argo into smaller parts, de Lacaille did not rename any of the stars. So Puppis does not have any stars named Alpha, Beta, etc., as the brightest stars in Argo Navis ended up in other constellations.

Canis Major and Puppis combined contain four Messier objects: M41, M46, M47, and M93. All four are open clusters. The brightest of these is M41, found just below (south) of Sirius. The pair M46 and M47 is found 14 degrees northeast of M41. Most amateur astronomers routinely view these three winter Messier objects. But M93 is often neglected since it is the smallest, southernmost, and faintest of these four Messier objects. To me it is a fine cluster with colorful stars as worthy as the others on my observing list.

Charles Messier discovered M93 in 1781 using his 3.3-inch refractor. He added it as the 93rd entry in his catalog of objects he did not want to confuse with comets. While not the southernmost object in Messier's catalog, M93 only rises as far as 17 degrees above the horizon from Paris where Messier observed.



M93 can be found 1.5 degrees northwest of the star Asmidiske (Xi Puppis), a third-magnitude star in the northern half of Puppis. The cluster shines at magnitude 6.19, not much fainter than M46. But it will appear fainter from mid-latitudes since it is lower in the sky. The light from M93 passes through more of our atmosphere than the light from M46. Thus, it experiences more atmospheric dimming or extinction. M93 has a diameter of 20 arcminutes and lies 3,400 light-years away.

M93 contains a colorful assortment of red, orange, and blue stars, and in 8-inch or larger telescopes, the stars sparkle like jewels. The cluster contains around 80 stars of eighth magnitude and fainter. A few stars that appear associated with the cluster are actually foreground stars, which is true of many open star clusters. The cluster has a wedge shape with the sharp edge pointing southwest. Some of the brighter stars east and south of the wedge are members of the cluster.

The brightest stars in the center of M93 are blue giants. The short lifespan of these stars tells us the cluster is approximately 100 million years old. The cluster contains red giant stars, too. Two of the brighter ones, both eighth magnitude, mark the point of the wedge. One of these, the one furthest from the cluster's center, is actually a foreground star only one-quarter as far away as the main cluster.

The image of M93 was captured with an eight-inch f/8 Ritchey–Chrétien Cassegrain with a 0.8× focal reducer/field flattener yielding f/6.4. The exposure was 60 minutes using an SBIG ST-2000XCM CCD camera. In the image north is up and east to the left.

This winter when sailing around the myriad galactic star clusters in the southern winter Milky Way, make sure that M93 is on your waypoint list. The cluster sits high on the mast of the former Argo Navis, but you won't need to be in a crow's nest to find it.

—Dr. James Dire

Opportunity Knocks at the *Reflector*

AD COORDINATOR NEEDED

After seven years of service to the *Reflector*, Carla Johns is stepping down as the magazine's advertising representative. Thank you, Carla, for helping make the *Reflector* the excellent publication that it is today!

Amateur astronomy has a wide field of view, featuring all sorts of interesting events and cool equipment. The Astronomical League is seeking someone to help amateur astronomy by volunteering to be part of the *Reflector* magazine team, and to assume the duties of the *Reflector* advertising representative. This is an opportunity to interact with star party and convention organizers, merchandise vendors, and equipment manufacturers while gaining a firsthand view of the state of the hobby.

The responsibilities of this volunteer position include:

- **Coordinate all incoming advertisements from multiple sources**
- **Send ad placement deadline reminders to all advertisers**
- **Review ads for spelling, grammar, image placement, correct information and contact advertisers to make any necessary changes**
- **Send all ads to design editor for placement**
- **Proofread draft issues to ensure all ads are included and accurate**
- **Generate invoices for each advertiser and send via email or hard copy (with complimentary current issue)**
- **Send invoices to treasurer to track payments**
- **Follow up with our treasurer to ensure invoices are paid in a timely manner**
- **Identify (and contact) potential new advertisers**
- **Field emails and answer questions from advertisers**
- **Track revenue for each issue**

We estimate about 10 hours per month should be adequate to fulfill all the above duties.

As Carla enthusiastically states, "This is a great opportunity to connect with star party organizers and industry experts across the U.S.!"

If this fun and important role is for you, please send your name to *Reflector* managing editor Ron Kramer at *managingeditor@astroleague.org.*

AAVSO NEWS

AAVSO SELECTS DR. BRIAN KLOPPENBORG AS EXECUTIVE DIRECTOR

The American Association of Variable Star Observers (AAVSO) is excited to welcome Dr. Brian Kloppenborg as the new executive director, effective September 16, 2022. "Brian brings the skills needed to advance AAVSO's scientific impact, combined with experience in management and project budgeting," notes AAVSO president David Cowall. Prior to AAVSO, Brian was a research scientist at Georgia Tech Research Institute, serving as a subject matter expert, lead engineer, product owner, and project director on over $120 million of sponsored programs.

Founded in 1911, AAVSO is an international organization enabling individuals to contribute to research on stars that vary in brightness. AAVSO has had 6,000+ star observers worldwide to date. Currently, these volunteers collectively report about 13,000 observations *every night* in support of professional astronomers, including those using the Hubble Space Telescope.

Dr. Kloppenborg holds a Ph.D. in physics, with an astrophysics specialty, from the University of Denver. His research interests span photometry, spectroscopy, astrometry, and long-baseline optical interferometry of eclipsing binaries, novae, and young stellar objects. His work has been published in *Nature*, *ApJ*, *JAAVSO*, and other scholarly journals. Brian also ran a small business providing data science, machine learning, and GPU accelerated computing services.

Dr. Kloppenborg is enthusiastic about his position, and takes it seriously: "With my background," Kloppenborg says, "not only do I understand where the science is and how the AAVSO can contribute, but also how to raise funds and implement successful programs." As an exciting part of implementing his ideas, Dr. Kloppenborg looks to form additional alliances.

AAVSO data specialist Elizabeth Waagen conveys, "Often, professional efforts provide data at a point in time. But an organized effort by generations of observers provides a long record of the star's activity and evolution. That's why astronomy needs an organization like us. A hundred years is a small slice in the life of a star, but stellar evolution can be detected within that time, so ongoing coverage is really important."

Dr. Kloppenborg is no stranger to AAVSO, having participated in a large AAVSO observing campaign, Citizen Sky – an effort to characterize the eclipsing binary star Epsilon Aurigae. Between 2009 and 2012, hundreds of observers followed this star, resulting in tens of thousands of photometric data points. The project was, for Dr. Kloppenborg, "the most fun job I ever had."

"Astronomy is an interesting field," Dr. Kloppenborg reflects, "because it is about self-actualization. As the new executive director, I want to empower the AAVSO's members to do their best and further their scientific endeavors."

—Lindsay Ward
AAVSO Communications Manager

League News

IMPORTANT NOTICE TO ALL MEMBERS REGARDING AMENDED BYLAWS

The Astronomical League has just completed a three-year project to amend its badly outdated, and in some cases outmoded and unworkable, bylaws. All amendments were passed by unanimous votes of the council in two virtual meetings held this past June and in the live council meeting held at Albuquerque in July.

It now falls to you, our member societies and individual members, to approve or disapprove these amendments. A two-thirds vote is required to pass bylaws amendments, and members must be given four months to review and approve them. You will be given the opportunity to approve or disapprove the amendments in their entirety or to approve some amendments while disapproving others. As usual, clubs will cast their weighted club vote.

On or before December 1, we sent an email to all club presidents, club ALCors, and individual members for whom we had valid email addresses on file. The email either attached, or provided a link to, the proposed amended bylaws, a summary of substantive changes, the ballot, and the old bylaws.

If you did not receive the email, it is because we did not have a valid current email address on file for you. Please contact national office manager Mitch Glaze at *rosters@astroleague.org* and provide him with a valid email or postal mail address so we can arrange to get the documents to you.

The use of email is critical since the mass mailing of 28 pages of documents to 310 clubs and over 500 individual members is cost prohibitive. Please note that the League maintains a strict policy against selling or divulging email addresses to outside parties and against unnecessarily emailing its own members. **The deadline for voting is March 31, 2023.**

NCRAL SEEKS NEW CHAIR

Are you an Astronomical League member living in North or South Dakota, Minnesota, Wisconsin, Iowa, Illinois, or the UP of Michigan? If so, you belong to the North Central Region of the Astronomical League (NCRAL).

Following the conclusion of three consecutive two-year terms, Carl Wenning will be stepping down as NCRAL's regional chair. Wenning was first elected in 2017 and is term-limited by the region's bylaws. His third and final term expires with the NCRAL regional convention on May 6. Candidates for the 2023–2025 chair position are now being sought.

Regional chairs oversee the operations of their regions and serve as chief communicators, holding the regions together and providing guidance. While Carl has edited NCRAL's *Northern Lights* newsletter since 2016, he points out that newsletter editorship is not part of the NCRAL chair's responsibilities.

If NCRAL members (affiliate members or members-at-large) are willing to consider serving as NCRAL chair after Carl steps down, they should contact him at *carlwenning@gmail.com* for details. Carl is currently developing job descriptions for all NCRAL officers and appointees to assist with future transition processes.

CALL FOR AWARD SUBMISSIONS

The application/nomination deadline for 2023 Astronomical League awards is **March 31, 2023.** No applications will be accepted before January 1, 2023. Award information, including applications, eligibility criteria, and available cash prizes, if any, will appear on the League's "Awards" webpage, *astroleague.org/al/awards/awards.html,* on or after January 1.

IMPORTANT: Due to the increasing problem of misdelivery of emails, award submissions are not deemed complete until you receive an email confirming receipt. If no confirmation is received within 48 hours of your submission, please contact the League vice president.

LEAGUE 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 31st year. League membership is not required. The top three winners receive plaques. The top two winners win expense-paid trips to the League's national convention (U.S. travel only) and receive Explore Scientific telescope prizes. The application, research paper, and a photo of the nominee must be emailed to *nyaa@astroleague.org*. Deadline: March 31.

Youth Service Awards: Qualified League members under the age of 19 who are engaged in service to the League, their clubs, their schools, and/or 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 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 cash prize. The application or nomination and a photo of the nominee must be emailed to *horkheimerservice@astroleague.org.* Deadline: 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 the top three finishers receive cash prizes. The application, astrophoto, and a photo of the astrophotographer must be emailed to *horkheimerparker@astroleague.org*. Deadline: March 31.

Youth Journalism Award: Qualified League members ages 8 to 14 are encouraged to enter a science essay in competition for the Horkheimer/O'Meara Youth Journalism Award. Club or regional officers may nominate candidates. The winner receives a plaque, and the top three finishers receive cash prizes. The application, essay, and photo of the young journalist must be emailed to *horkheimerjournalism@astroleague.org.* Deadline: March 31.

LEAGUE AWARDS

The following general League awards are open to all League members regardless of age. Winners receive award plaques.

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

Williamina Fleming Imaging Awards: These awards, now generously sponsored by Explore Scientific, are open to female League members who are 19 years of age or older. Awards are given in four categories of astrophotography: Deep Sky (>500 mm focal length, excluding Solar System), Solar System (>500 mm), Rich Field (201–500 mm), and Wide Field (200 mm or less). Images submitted by professional astrophotographers as defined in the rules will not be accepted. Submissions are made by emailing the entry form, a photo of the entrant, and up to three .jpeg attachments not exceeding a total of 25 megabytes to *flemingaward@astroleague.org.* All submissions must consist of images taken and processed solely by the individual. Deadline: March 31.

Sketching Award: The Sketching Award recognizes the fundamental role that sketching plays in observing. The award is open to League members of all ages. In addition to the winner's plaque, cash prizes are awarded to the top three finishers. Sketches should be submitted as high-resolution .jpeg files (10 megabytes maximum) along with a .jpeg photo of the applicant to *sketch@astroleague.org*. Deadline: March 31.

—Chuck Allen

CALL FOR OFFICER NOMINATIONS

Nominations for the office of League secretary for the two-year term beginning on September 1, 2023, must be received by nominating committee chair Chuck Allen at *chuckallen@gmail.com* no later than March 31, 2023.

The secretary records and distributes minutes of all council, executive committee, and business meetings, provides a summary of the council and business meetings in the *Reflector*, maintains and distributes copies of current League bylaws and standing resolutions, issues notices of council and executive committee meetings, transmits to the executive committee or council the results of voting conducted by electronic means, and files required annual or biennial corporate reports with the Missouri Secretary of State.

Nominations should be accompanied by (1) a background statement of 250 words indicating qualifications and/or reasons for seeking the position and (2) a photo of the nominee, both for inclusion in the *Reflector* and on the ballots.

—Chuck Allen

ASTRONOMICAL LEAGUE LIVE! PROGRAM

Join the Astronomical League on its monthly online Astronomical League LIVE! broadcast. The two-hour program begins with Astronomical League updates and short talks by League officers and members followed by a feature presentation by a keynote speaker.

Over the past two years, a wide variety of topics have been covered – everything from astrophotography to the zodiacal light to planetary geology. You can watch the broadcast live on the League's Facebook page, the Explore Scientific website under Explore Alliance, and the Explore Scientific YouTube channel. These programs are also recorded, so you can view them at a later date on all the above sites.

For more information, and to see who will be appearing on the next Astronomical League LIVE!, please see the Astronomical League's Facebook page *(facebook.com/Astronomical.League)* or website *(astroleague.org)*.

OBSERVING PROGRAM COORDINATORS NEEDED

The Observing Program Division is once again in search of additional Observing Program coordinators. If you have a desire to get more involved with the Observing Programs, we want you! These Observing Programs currently need a coordinator:

- **Jupiter Observing Program,**
- **Mentor Observing Award,** and
- **NASA Special Observing Challenges.**

We also have two new Observing Programs recommended to the council for adoption in July. If they are adopted, they, too, will need coordinators. There may be more.

If you are interested, please send an email to Aaron Clevenson at *aaron@clevenson.org*. Indicate for which Observing Program(s) you would like to be considered, or you can say "all openings." Emails must be received by December 31, 2022, since we will begin the interview process in January. Current coordinators may also apply, but the best practice is to limit the total number for each coordinator to three or fewer Observing Programs. Thank you for helping the Astronomical League and the Observing Program Division.

FIFTY YEARS OF ASTRONOMY DAY

It was a simple idea. For decades observatories had open houses, science centers had exhibits, planetariums had programs and schools, universities and colleges had classes. They all had two things in common. People had to travel to experience astronomy and they had to know they were interested enough to want to travel.

BRINGING ASTRONOMY TO THE PEOPLE
ASTRONOMY DAY

Then in 1973 along came Doug Berger, then with the Astronomical Association of Northern California, with a simple idea. Instead of making people travel, why not go to the people? Maybe these people did not even know they were interested in astronomy. Maybe they had a passing interest but did not know about local astronomical resources. Berger's idea was to to bring astronomy to the people and meet them where they are. By setting up telescopes in parks, libraries, and street corners and putting astronomical exhibits in shopping malls, he not only helped spark that latent interest in astronomy but also publicized all those local resources.

After Astronomy Day, attendance at planetariums increased, astronomy club membership grew, and kids were exposed to our fascinating Universe.

During the past fifty years, thousands of people worldwide have been exposed to astronomy and thousands of dollars have been awarded to organizations hosting Astronomy Day events via the Astronomy Day Award.

To help any organization organize Astronomy Day events, the League has produced a handbook chock full of ideas, resources and tips on how to host a successful event. So why not plan an event and make the 50th anniversary of Astronomy Day the best yet?

Astronomy Day is **April 29, 2023.** For more information on all of Astronomy Day go to *astroleague.org/al/astroday/astrodayform.html*

—Gary Tomlinson
Astronomy Day Coordinator

GALLERY

THIS PAGE TOP: Herb Steck (Astronomical Society of Eastern Missouri) captured this image of a plane transiting the Sun from St. Peters, Missouri, using a Sky-Watcher Esprit 80 refractor with Baader Solar Film and a ZWO ASI 174MM camera.

THIS PAGE BELOW: Jeffrey O. Johnson (Astronomical Society of Las Cruces) took this image of M81 from his backyard in Las Cruces, New Mexico, with a Takahashi TOA-130F refractor with a QSI 690wsg CCD camera. Image cropped slightly and rotated 90° counterclockwise from original presentation.

NEXT PAGE: M.J. Post (Longmont Astronomical Society) captured this image of IC 1284 using a PlaneWave CDK14 telescope and a ZWO ASI 6200C color camera from his Dark Sky New Mexico observatory in Animas, New Mexico. Image cropped to fit page and rotated 90° counterclockwise from original presentation.

OVERLEAF: Steven Bellavia (Amateur Observers' Society of New York) captured this image of supernova remnant G65.3+5.7 using a Canon 200 mm f/2.8 USM lens and a ZWO ASI 294MM Pro camera.

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

ROYAL ASTRONOMICAL SOCIETY OF CANADA

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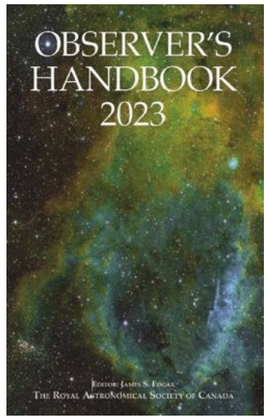

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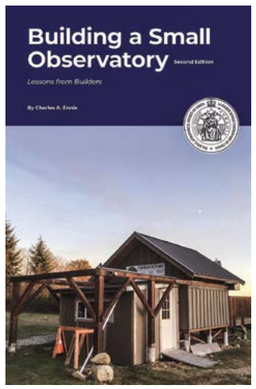

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This book is the result of interviews with 140 small observatory owners to learn what it takes to fund, build, and operate a small observatory. It will help you maximize your chances of successfully creating a trouble-free installation, and help find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

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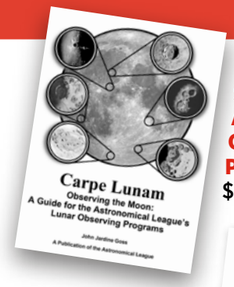

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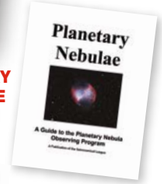

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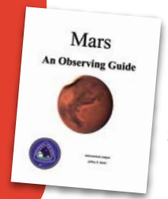

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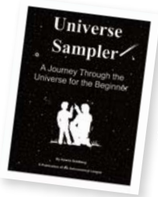

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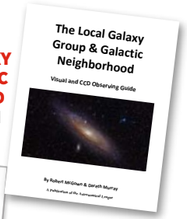

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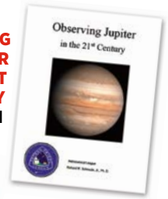

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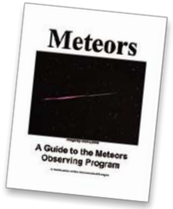

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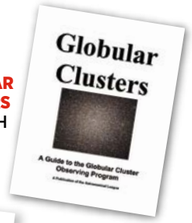

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A Very Powerful 6-Inch Telescope

By William Romanishin

I am a retired professor of astronomy, having spent many years on the faculty of the University of Oklahoma. Although I am retired, I still do research on minor bodies in the middle and distant reaches of our solar system, using large research telescopes located in Arizona. This anecdote tells of a very different class of telescope – a 6-inch Newtonian reflector that I constructed as a teenager. This telescope was to play a very important and totally unforeseen role in my life.

I grew up near Pittsburgh. I was only five years old when the Russian Sputnik amazed and frightened people across the Western world, so I don't have any firsthand memories of that first satellite. But I do remember well the first U.S. crewed space programs – Mercury, Gemini, and Apollo – which helped spark my interest in space and astronomy. When I was 13 or 14, Santa brought me a small Japanese refracting telescope. Unfortunately, I soon realized it was of low optical quality: everything showed red and blue halos. In the 1960s the entry-level consumer optics produced in Japan were light-years – in quality and price – below the superb Japanese telescopes available now! I read up on telescope optics and found that, of course, I was seeing the effects of chromatic aberration. I knew that Jupiter should not show smeared red and blue bands: I needed a reflecting telescope! I spent hours coveting the Cave and Astrola reflectors pictured in the ads in the *Sky & Telescope* magazines I read in the library. But those telescopes were far beyond Santa's budget.

Upon further reading I learned that one could build a Newtonian reflecting telescope at a significantly lower monetary cost than buying a completed instrument. Fortunately, our house had a basement with unused workspace, and my grandfather had left us some tools and lots of wood and other materials. After a summer working as a caddy at a local golf course, I was able to purchase a 6-inch mirror-making kit from Edmund Scientific. I spent untold hours walking around a 55-gallon drum that held the glass as I ground and polished it. As for the telescope mount, my father was able to make me a decent right ascension axis as he had access to a metal lathe where he worked, while the declination axis I made had bearings made of pipe threads. After much trial and error, I had a working telescope. In the process I gained a lot of practical knowledge about optics, mechanical construction, and astronomy.

At this point I was in my last year of high school, and I wanted to go to college and study astronomy. Neither of my parents had gone to college, and I had no idea where to apply or what kind of school I might get into. The people at my small high school were of limited help as they had no experience sending students on to any college except for the state teacher's college. So, to hedge my bets, I spent the rest of my summer earnings on application fees to a large number of colleges, ranging from the local community college to my dream schools: Caltech, Princeton, MIT, and Harvard. The mailman eventually delivered the dreaded "thin envelopes" (each containing a one-page rejection letter) from Caltech, Princeton, and MIT. I was almost ready to commit to attending one of my "safe" schools, but then I got a phone call from a man on the Harvard admissions committee. He told me they were working on a final list of students they were going to accept for the fall of 1970, and that my application was still under consideration. However, they had to make a final round of rejections. He had called to tell me that the admissions committee wanted everyone who remained under consideration to complete an in-person interview (no Zoom meetings back then!) with a Harvard alum. The reports from the interviewers would help the committee members make their final decisions.

The author at his current favorite telescope: the 4.3-meter Lowell Discovery Telescope in Arizona. Photo by Dr. Steven Tegler of Northern Arizona University.

The Harvard admissions office arranged for me to meet with a Harvard alum at his office in downtown Pittsburgh. I scraped up the 85-cent bus fare to get downtown and found myself at one of the tallest skyscrapers in the city. I went up to the top floor and a secretary ushered me into the interviewer's office. I have no record of the interviewer's name, but I vaguely remember that he was the president or vice president of a bank. His office looked like something out of a Hollywood movie: dark wooden paneling, expensive furniture, paintings on the walls, and fantastic views of Pittsburgh. Needless to say, I was extremely apprehensive – I had never previously been in any even remotely similar situation.

The man sat behind a large desk flipping through a folder which I saw contained my application materials. He looked at me and said something like "I don't see anything in here about sports. What sports do you play?" I had spent some time thinking about what I might be asked, but this question completely flummoxed me as I never thought I would be asked about sports. I managed to stammer that I wasn't interested in sports. The man made a disappointed grunt and wrote something on my folder. I was ready to run screaming out the door, but he quickly said, "Well, if you don't play sports, what do you do with your free time?" This was exactly the question I had hoped for, so I calmed down and answered, "I have been building a telescope. I am very interested in astronomy. I wanted a nice telescope and didn't have money to buy one, so I made one myself." He said, "Please tell me about that." I described how I made the mirror, rubbing together two disks of glass with abrasive between them until they had the correct shape, then polishing the concave disk until it was smooth. I told him how I tweaked the mirror shape from spherical to parabolic to an accuracy of few millionths of an inch, using a measuring device I constructed from a coffee can, a light bulb, and a razor blade, and how I attached a motor and gears to the mount so that the telescope would track the stars. He asked me who had helped me do all this and I told him that I had a little help from my father with the mount, but that I learned about mirror making only by reading books. As I was leaving the interviewer remarked that in all his years of conducting interviews, he had never heard a story quite like mine. I left feeling that, after the initial near disaster, the interview had gone remarkably well.

A few weeks later I received my "thick envelope" from Harvard. I can only surmise that the interview report had tipped the balance in my favor. I had very good grades and test scores, but certainly everyone on the penultimate list had those as well, undoubtedly most from better high schools than the one I had attended. Along with the letter of acceptance were offers of a substantial scholarship grant, a low-cost long-term loan, and promise of a part-time campus job that all together would pay for almost all the cost of my attending Harvard. The telescope had turned out to be a very powerful 6-inch telescope! ✶

Dr. William Romanishin is emeritus professor of astronomy at the University of Oklahoma. His personal website is hildaandtrojanasteroids.net.

NEVER TOO OLD TO BE A STARGAZER

By Tom Van Buskirk

I did not get into astronomy until I was 56 years old. I always enjoyed the night skies before living in bigger cities where the light pollution limited what could be seen. No more Milky Way and not much of the Little Dipper was visible. I was living in Downey, California, a few miles east of Los Angeles, when I got interested again and wondered what or how I might be able to enjoy the night skies again.

I found that there was the Columbia Astronomy club in Downey less than a mile from my house. It was a small club, with 15 to 20 individuals showing up to a meeting, which made me feel very welcome. I got to observe a lot of things that I never knew about when, after the meeting, some of the members set up their scopes. I was hooked! I was told about the Riverside Telescope Makers star party at Big Bear, California. What a blast that was, with all kinds of events going on night and day. I happened to have some extra money and came home with a 10-inch Dobsonian reflector. I still have it, but it's just too cumbersome to haul in and out of the backyard. It taught me how to star hop and find targets in the different constellations. It was my only scope for about 20 years. It was great fun finding targets such as Mizar/Alcor and Albireo. Due to the light pollution from L.A. I focused on double stars and the Moon. I did observe the results of the Shoemaker-Levy 9 impact of Jupiter, a great example of things that happen in our universe. I also enjoy finding things that I see in the magazines. I became a big fan of "Deep Sky Wonders" by Sue French in *Sky & Telescope*. One thing I regret is I didn't keep a log of my observing for nearly 19 years. That is one thing I highly recommend to anyone I help getting started in astronomy. I learned to prepare a list of 5 to 10 targets or an observing program from one of the astronomy magazines of what I'm going to observe before I go out for the night. I may find that something else catches my interest and that is okay, but I have my list for another night of observing.

Due to a fall in 2009 that caused a back injury, I was unable to do any observing for about a year. I bought a 90 mm refractor from a neighbor who was no longer using it and started observing again. When I recovered, I found the Dobsonian was just too much for me to work with anymore. One of the club members had a 150 mm Maksutov Cassegrain on a go-to equatorial mount for sale, which I bought. The go-to made observing a lot easier for me after the back injury and advancing age (76).

I moved to Anthem, Arizona, at my daughter's request in June 2014. Anthem is on the north border of Phoenix. After getting settled in, I found the Desert Foothills astronomy club in New River, Arizona, now inactive, which gave me membership in the Astronomical League. I knew nothing of the AL, but I was interested in the observing programs. My 11-year-old granddaughter was showing some interest in stargazing so I started her on the Lunar Observing Program, but she lost interest and then the family moved about 35 miles away. She is now 19 and has a car and has expressed interest in astronomy again; we will see what happens. I completed the Lunar program and decided to send for the certificate and pin to show her in hopes that would encourage her.

I started the Lunar II program but my late wife became ill and I did very little observing until she passed away. I got back into regular observing in 2017. I completed the Double Star Telescope and Binocular programs.

In September 2020 I bought some casters for the go-to 6-inch scope tripod; what a difference that made. No more taking the tube and counterweight off and lugging the tripod and mount out and putting the telescope back together for a night of observing. Just open the door and roll it out 30 feet into the backyard. Casters for telescopes can be found at *scoperoller.com*.

The Urban Observing Program appealed to me because I'd had enough of the double

Background image credit: ESA (European Space Agency)/Hubble & NASA

stars and the Moon for a while. I got off to a good start in November 2020. I was out with my 15×70 binoculars, and after finishing my planned list for the night, I took a look at the Urban OP list and found Alpha Persei visible to the naked eye. Melotte 20 showed up very well in the binoculars. I found that most of the open clusters on the list were fairly easy. However, as I moved on, I found things I could not resolve. For example, the open cluster NGC 7789 was very faint and hard to resolve. Most of the double and multiple stars were not too difficult, although I did have a problem splitting Gamma Leonis. My O III filter was a big help. Globular clusters, nebulae, and galaxies were the most difficult of the list. I had to wait for NGC 4374, galaxy in Virgo, to get high enough in the sky to be sure of what I was seeing. The galaxy NGC 4406 was also difficult, very close to galaxy M84. I think the hardest target for me was NGC 6210, a planetary nebula in Hercules. It took a few nights to find I was mistaking it for a star; again, the O III filter was a help. I replaced the 6-inch Mak-Cass with an 8-inch Cassegrain tube in June 2021. All of the targets in the Urban OP were observed from my backyard. The program took me a year and one and a half months to complete.

So, what have I learned? Don't be pessimistic, thinking that you will not be able to find the target. Don't look for nebulae, galaxies, or globular clusters if the Moon is up or about to come up. Some of the targets were resolved with a 90 mm refractor and 15×70 binoculars. If you don't find a target on your first try, wait an hour or try another night. I tend to forget to use my filters; set them out where you can see them. Yes, I have some problems, as I am very close to Phoenix to my south. Trees block my vision to the south and west. Polaris is just above my house so I can align the go-to scope. The Urban OP gave me the incentive to try for almost any target, and more than just once if I don't find it on the first try.

I am now 88 years old and working on the Advanced Binocular Double Star, Lunar II, and the Carbon Star programs. Am I too old for stargazing? Not yet!

A big thank you to the people of the Astronomical League. ✶

A BITE OUT OF THE SUN

By Tom Rusek

It was Sunday, May 20, 2012, and I was headed for the ASMS (American Society for Mass Spectroscopy) Conference in Vancouver, Canada, to present a poster. My flight originated in Washington, D.C., routed through Dallas–Fort Worth, and on to Vancouver. This was also the day of an annular solar eclipse visible primarily in the western portion of North America.

We left Dulles Airport at 1 p.m. Eastern time and had a 3 hour layover in Texas. My next flight was to leave at 6:26 p.m. Central time. The peak time for the annular eclipse was due around 6:15 to 6:45 p.m. Pacific time, but partiality spread over a larger distance and over a greater time frame. This was going to be a very long day, but I was excited to maybe be able to see the eclipse from the plane above the clouds somewhere between Texas and Canada. The timing was going to be close, but all I could do was hope for the best. I was carrying only a digital pocket camera – as it turned out, the best choice.

As I sat in the DFW terminal, I imagined what the next flight would bring and how all this all would turn out. Would the passengers (or even the pilot) know of today's astronomical event or even care? One thing I did not fail to do was to get a window seat on the left (port) side of the plane. If the jet was to head north, west, or northwest from Texas to Canada, I would have a good vantage point to see the eclipse out of my window in the western sky. It would be about a 3-hour flight so the timing seemed to be right. The only thing I wasn't too sure of was where I would be around 6:15 p.m. in relation to the partiality of the eclipse.

Finally, it was time to board and get to my assigned seat. The skies were clear and I was ready. It was now 6:30 Central, 4:30 Pacific.

As the flight progressed, I surveyed the passengers who were seated around me. I was surrounded by the usual mix of people traveling to Vancouver for whatever reason. A group of Japanese students were nearest to me, probably going to the conference. My hopes were invigorated because students are always interested in this kind of stuff. I asked my two nearest neighbors if they knew about the eclipse and neither did. From what I perceived, no one knew of the eclipse. Anyway, I continued reading my book. I took out my camera and surveyed the sky. Luckily, I did bring a pair of eclipse glasses that I used. Nothing! I continued reading my book, but as time went on, I became more and more nervous and jumpy in my seat. I could feel the excitement building inside of me. Quickly, I took another check of the sky. Nothing! The Sun was still full. As it was, the pilot was not heading directly toward the Sun but a little northerly, so I had a decent view, but it was close. I was right up against the window looking forward with no room to spare. A larger camera would have been out of the question. I could only see the sun with a small camera – my pocket digital camera.

I could not read my book any longer. I was too excited. I wanted to stand up and give everyone a lecture about what was soon going to happen (before everyone would have mutinied and tossed me out one of the hatches without a parachute). I was so excited just waiting for the Moon to take a bite out of the Sun. It had to happen. I could not live with myself if something went wrong.

Another 15 minutes – nothing – and I noticed that the jet was slowly compensating for Vancouver by heading more and more directly into the sun. Oh no! Don't do this to me, please. But I still had room if I placed the camera right up against the window. Wow! Airplane windows are filthy and the way light travels through them at extreme angles is near disastrous. I also had to hold the eclipse-filtered glasses in front of the camera. I needed another hand. Could I juggle the camera and the glasses and still hold everything still while the jet encountered turbulence?

Another 15 minutes. Wait, what was that? I could see a slight bite out of the Sun. Here we go! It had started. I wasn't sure where the plane was state-wise but at least I may have lucked out. I could hardly sit still. I practiced with the camera and got a few shots as the missing piece of the Sun grew. People started looking at what I was doing. I know that I must have looked strange holding all this stuff in my hands and straining to get the best angle. The Sun kept getting smaller and the jet kept slowly veering into it. The Sun was approaching the front of the plane.

It was also getting considerably darker outside. Hey people! Do you notice anything unusual out of your window? Does it get this dark at this time where you live in May? Everyone was oblivious to the darkness. But in reality, it wasn't dark enough unless you expected something like an eclipse. Also, many shades were pulled down. Looking out an airplane window can be frightening for some. As it turned out, the pilot and the co-pilot didn't notice either.

My juggling act did indeed attract some attention and I quietly let some nearby passengers know what was going on outside. Some were interested but most were not. No one wanted to look through my eclipse glasses except for the guy next to me. He thought it was cool. Well, I kept taking photos and improving my technique using my zoom lens. I held up my camera for the people

behind me to see the partial eclipse and they were thankful for the experience.

I'm not sure what time it was, but the uneclipsed portion of the Sun was small, and I did my best with the camera as the jet veered more and more into it. It was also getting hazy and bumpy. The Sun was barely visible from my vantage point. It was right at the front edge of the window. I could barely fit the image into my camera viewer. My camera was small, but it was all that would have worked. Sometimes smaller is better.

Soon after that, it was all over. The jet headed directly into the sun. I began to relax and to collect my thoughts. I did it! I caught the partial solar annular eclipse under extreme conditions. My photos are crude compared to others', but I don't care. I did what I could with what I had. I will not compete with anyone, nor will I accept any criticism. I had the thrill and the experience of a lifetime, and I was satisfied with my performance.

As I disembarked the plane, I passed the pilot and the co-pilot. I asked them if they knew about the eclipse. They did not. I should have informed them about it before we took off, but you know how it goes. I also did not want people to go crazy and stare directly into the Sun.

Maybe I'll become an eclipse chaser. Maybe I'll only do it above the clouds. We'll see. ✶

Tom Rusek is a member of the Harford County Astronomical Society

A GALAXY CLUSTER MAP OF THE SKY

by Terry McQuistion

Our universe is estimated to be 13.77 billion years old. Based on recent observations of proto-galaxy formation by the James Webb Space Telescope, we can say that the first signs of galaxy formation occurred about 250 million years after the Big Bang.

I've always been fascinated by how galaxies and large-scale structure originally took form. With that fascination driving me, I decided to create a hand-drawn map showing our universe in color. I mapped each constellation by how many galaxy clusters were within the constellation's boundaries. The eleven largest concentrations of clusters on the map are depicted in red. Each red area on the map indicates the presence of 139 to 255 galaxy clusters.

The smallest of these eleven concentrations lies in Draco. One of its components is the Abell 2218 galaxy cluster located 2 billion light-years away. Abell 2218 is one of the most photographed clusters in the sky. Substantial gravitational lensing can be seen in images of the cluster, evidence of the presence of extensive dark matter.

The largest of the eleven red concentrations lies in the southern constellation of Eridanus and consists of 255 galaxy clusters.

These concentrations of clusters are, of course, linked in a "cosmic web," creating large supercluster structures. There are fourteen known major supercluster structures; the largest is the Sloan Great Wall, which is 1.37 billion light-years long. The second largest is the Pisces-Cetus Supercluster Complex located 800 million light-years from Earth. This supercluster is estimated to be 1 billion light-years long and 150 million light-years wide. The supercluster of which the Milky Way is a part, the Virgo Supercluster, is a subset of an even larger structure known as Laniakea ("Immeasurable Heaven" in Hawaiian), which is 250 million light-years in extent and home to approximately 100,000 galaxies.

The map took me five years to complete. The size is just under 8 feet long and 3 feet wide. It won a gold medal in sketching and art in the Great Lakes Region's imaging and sketching competition held at the 2019 Hidden Hollow Astronomy Conference. ✶

Terry is a member of the Richland Astronomical Society in Mansfield, Ohio, and a frequent user of the club's Warren Rupp Observatory. The RAS hosts the Hidden Hollow Astronomy Conference each September.

Image shows a small portion of the map. Contact Terry regarding copies of the map at ***330-234-7820.***

PLANETARY NEBULAE: FROM MESSIER TO ABELL

WHAT THEY ARE, AND HOW TO OBSERVE THEM

By Larry McHenry

Planetary Nebula – when I hear those words, I think of a specific type of deep-sky object. It's a type of object that's always interesting and fun to observe or image. They also bring to mind their descriptions: colorful ephemeral ghosts, luminescent wispy shells of dying stars. Little crystal ball gems in the night sky, delighting amateur astronomers using small or large telescopes. They range from large, easily located extended disks showing great detail to tiny, almost point-like, and challenging to find. Interstellar graveyards giving up secrets of stellar evolution while spreading their wealth of star forged elements across space. I would like to bring these ethereal objects "down to Earth" by discussing what they are, why we call them planetary nebulae, introduce some of the historical and modern people behind these objects, and explain how to go about observing them. Hopefully this will lift some of the mystery around these objects, and you will find them as interesting to hunt as I do.

WHAT ARE PLANETARY NEBULAE?

Planetary nebulae are clouds of interstellar matter, thin shells of ionized gas and dust. They mark where a star is slowly dying. These nebulae come in a wide variety of shapes and appearances. The central star that creates a planetary nebula is in an advanced state of stellar evolution, at or just beyond the end of its nuclear life cycle. In one of the previously sunlike star's final stages, the force of gravity causes its core to contract, and it ejects a portion of its mass in a gaseous shell. Ultraviolet radiation and light from the dying star then energizes the shell of expanding gas, causing it to appear as a bright nebula.

HOW PLANETARIES GOT THEIR NAME

A lot of amateurs mistakenly credit Charles Messier for naming these types of deep-sky objects. But that is incorrect.

In 1764 Messier discovered what would become the first planetary nebula, M27 (the Dumbbell Nebula) in the constellation Vulpecula, and listed it in his catalogue of nebulous objects. Messier, with help from fellow French astronomer and comet hunter Pierre Méchain, went on to add three more of these objects to his catalog (M57, M76, and M97), but he never described them as resembling planets. In 1782, William Herschel, the discover of the planet Uranus a year earlier, first used the term "planet" in his description of these objects: "These bodies appear to have a disk that is rather like a planet, that is to say, of equal brightness all over, round or somewhat oval, and about as well defined in outline as the disk of the planets...." Herschel went on to use the term planetary in his publications for describing these objects. So the credit for the term planetary nebula goes to William Herschel.

HOW TO OBSERVE PLANETARY NEBULAE

Planetary nebulae can be found all along the glowing band of the Milky Way. Unlike the irregularly shaped glow of a diffuse emission nebula, planetary nebulae live up to their name in that they are generally circular objects that somewhat resemble a planet. Some are evenly bright or illuminated across their disk, while others have a darker central region giving them a ring shape. And in some planetaries, the central star that created the nebula can still be seen. Visually, if the planetary nebula's surface brightness is high enough, you may be able to see color. Although most dim planetary nebulae will appear grayish, the brighter planetaries will show variations of green and blue colors. In general, for visual observers, it's best to hunt planetaries starting with low-power, wide-field eyepieces to identify the target area. Once the planetary is centered, switch to higher magnifications and filters to try to extract details in the nebula shells, along with the central star.

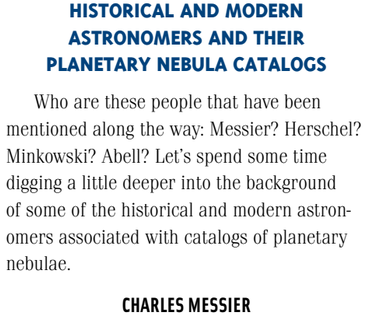
Messier's planetaries are bright objects and are easily visible in most telescopes, even under suburban skies. The planetary nebulae from the Herschel catalog are also generally visible in medium-size telescopes, though some will require larger reflectors and a dark country sky. But the planetaries listed in the Abell catalog are generally very old, extended, and faint, which makes these objects very challenging to observe. The Minkowski planetary nebulae are even more difficult, most appearing starlike and embedded in crowded Milky Way star fields, showing little to no disk nebulosity. You'll need a large reflector or some type of imaging setup to pull these in.

HISTORICAL AND MODERN ASTRONOMERS AND THEIR PLANETARY NEBULA CATALOGS

Who are these people that have been mentioned along the way: Messier? Herschel? Minkowski? Abell? Let's spend some time digging a little deeper into the background of some of the historical and modern astronomers associated with catalogs of planetary nebulae.

CHARLES MESSIER

In July of 1764, while out comet hunting, Charles Messier ran across a bright nebula that would become the 27th object on his list of objects to avoid while comet hunting. Messier referred to M27 as "a nebula without a star... it appears of oval shape." The 18th century French Astronomer Charles Messier is best known for his catalog of nebulae and star clusters, first published in 1771. This list of 110 deep-sky objects is known to today's astronomers as the Messier Catalog. During his comet searches, Messier kept running into these diffuse objects that would frustrate him. So Messier began a list to help comet hunters avoid these false comets. Messier worked as an astronomer for the French Navy. His observatory was located within the city of Paris at an old hotel. The observatory was built atop a tower and was a wooden structure with large side windows that could be opened for observing. For the majority of his observing work, Messier used a small 4-inch refractor. Over the course of his lifetime Charles Messier discovered 21 new comets, but it is his list of fixed diffuse objects to avoid while comet hunting, his *Catalog of Nebulae and Star Clusters*, that today's modern amateur astronomer seeks out for bright showcase galaxies, nebulae, and star clusters.



(Top) M27 as sketched by the author in 1984 using a 10-inch f/5.6 Dobsonian and a 27 mm eyepiece. North is up. (Bottom) M27 photographed by the author in 2021 with an 8-inch SCT and L-eNhance narrowband filter, using a ZWO ASI294MC camera.

WILLIAM HERSCHEL

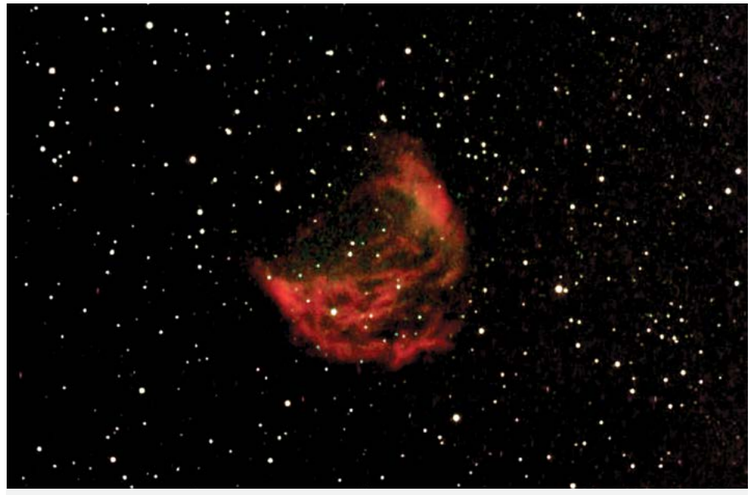
In William Herschel's deep-sky catalog, one of the major classification categories (Class IV) is called planetary nebulae. There are 77 objects listed, but interestingly, only 20 of these objects are true planetary nebula. Herschel was known to drop objects that he was unsure how to classify into this category. 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 Herschel and his sister Caroline. For his discovery of the planet Uranus, King George III of England knighted Herschel in 1782 as the King's personal astronomer and gave him an annual pension. Using his new wealth, Herschel built a new permanently installed giant telescope, the "20-foot reflector" (which had an 18.5-inch speculum metal mirror). From 1782 to 1790, using this instrument, the Herschels conducted systematic surveys of the night sky, in search of deep-sky objects, and discovered over 2,400. William Herschel was one of the most notable observers in the history of astronomy, and is often referred to as the father of observational astronomy.

NGC 1514 photographed by the author in 2021 with an 8-inch SCT and L-eNhance narrowband filter, using a ZWO ASI294MC camera.

RUDOLPH MINKOWSKI

German-American astrophysicist Rudolph Minkowski was born in Strasburg, Germany, on May 28, 1885. In 1935, he accepted a research assistant position at Mt. Wilson Observatory and immigrated to the United States. Minkowski is best known for his Mt. Wilson research work on supernova remnants with astrophysicist Walter Baade. But in the late 1940s he published three versions of a paper titled "New Emission Nebulae" in which he listed over 200 planetary nebulae that he had studied for their spectra, galactic distribution, and motion.

Most of Minkowski's planetary nebulae are very small, starlike (less than 10 arcseconds in diameter), and very faint (fainter than 13th magnitude) and are difficult visual observations. The best way to visually confirm that you have found one is to use your ultra-high contrast or O III filter and rapidly pass it back and forth between the eyepiece and your eye, causing the planetary to "blink" in brightness compared to the other stars in the field of view.



Abell 21 photographed by the author in 2021 with an 8-inch SCT and L-eNhance narrowband filter, using a ZWO ASI294MC camera.

GEORGE ABELL

American astrophysicist George Abell was born on March 27, 1927, in Los Angeles. After graduating from high school, George enrolled at Caltech where he studied physics and astronomy. Abell's first professional job was as a Caltech astronomer working on the National Geographic Society – Palomar Observatory Sky Survey (POSS), created using the Palomar 48-inch Schmidt telescope. George's primary research was reviewing the POSS survey photographic plates looking for the formation of galaxy clusters. But while searching the plates for faint galaxies, he ran across a number of unreported planetary nebulae. From the new data contained on the plates, Abell compiled a list of 86 very old and faint planetary nebulae, which he published in 1966. Generally it's best to save hunting for Abell planetaries for trips to dark sky locations and nights of excellent transparency. While some Abell objects can be observed using smaller telescopes, most of these objects require large telescopes.

I hope this introduction has inspired you to search out and explore these rewarding celestial objects. I encourage everyone to try their hand at finding and observing the ghostly disks of these elusive deep-sky objects, the planetary nebulae of Charles Messier, William Herschel, Rudolph Minkowski, and George Abell. ✶

Larry McHenry's website is stellar-journeys.org

CITIZEN SCIENCE USING REMOTE TELESCOPES

By Brad Young

Amateur astronomers have a huge role to play when it comes to citizen science. However, we don't all have the high-end equipment to involve ourselves in the best opportunities. Remote telescopes offer a solution that may work for you. The Astronomical League considers remote telescopes "go-to telescopes where the observer is not responsible for maintenance and operation of the telescope." However, the observer is responsible for the selection, definition, and timing of the observation, and the exposure times, cadence, filters, and processing used to create the final images. They are also responsible for measurements such as astrometry (position), photometry (brightness), and other useful data. Several AL Observing Clubs accept remote telescope observations for both the main program and the citizen science continuation of the program.

VARIABLE STARS

Variable stars provide several ways to perform citizen science. Measuring variability has taught us the inner workings of stars, set stellar and galactic distances, and helped explain how stars form and die. Some of the best-known targets can be seen naked eye or with a small telescope; you may wish at some point to find dimmer and more challenging targets such as young stellar objects and novae, or do spectroscopy. All these can be done using remote telescopes, and the findings reported to the American Association of Variable Star Observers (AAVSO).

SUPPORTING HUBBLE MISSIONS

One exciting offshoot of this is to provide ground support for Hubble Space Telescope missions. The science being done by HST may be adjusted based on this ground support, with changes made or even rescheduling HST observations based on findings by amateurs. In some cases, a star may be best observed when brightest, or it may have to be delayed if a flare up occurs. Often, the request is for multiband (B, V, R, I) imagery and even spectroscopy. In all cases, the requests are time sensitive.

The AAVSO publishes alert bulletins on upcoming missions that need observations of certain variable stars to support an upcoming or ongoing Hubble mission. The bulletins provide details on the star, the timing, the filters requested, and some background on what the observation is about.

EXTRAGALACTIC SUPERNOVAE

SN 2022rms, image by the author.

Another exciting type of object is extragalactic supernovae (EGSN). One famous one this year (SN 2022rms) occurred in NGC 4647, a galaxy visible next to M60. Not only was the supernova brighter than its host galaxy, but its location made it easy to observe.

ACTIVE GALACTIC NUCLEI

There is also a group of variables known as active galactic nuclei which are not the same as EGSNs but indicate variability in the nucleus itself. This group includes objects such as quasars, blazars, BL Lacertae objects, and more. These usually have AAVSO identifiers and can be easily reported, although many of them are faint and require larger scopes or long exposures.

ASTEROIDS

With asteroids, several opportunities are open to amateurs using remote imaging. The Minor Planet Center (MPC) provides orbital data for all known asteroids and comets to use for preparing observations. Association of Lunar and Planetary Observers (ALPO) publishes the *Minor Planet Bulletin* four times a year, a journal of various findings, especially determinations of rotational periods for asteroids. You can either use their template to write an article for their journal, or if you prefer, you can use data you've gathered and the methodology and determine rotational periods yourself. Also useful in the *Minor Planet Bulletin* is the annual list of "Minor Planets at Unusually Favorable Apparitions," which appears in every January–March issue.

Another way that remote telescopes are used in minor planet studies is the Astronomical League's Target NEO program (formerly Target Asteroids program, co-sponsored by NASA and University of Arizona). This effort is centered on determining characteristics of asteroids that are near-Earth objects, and others that may be worth visiting, landing on, or even returning samples from such as the recent success at Bennu. They accept reports in MPC format so you won't have to do any extra work to provide the data; however, in this case you will need to provide a FITS (image) file in addition to the report.

SATELLITES

Satellite tracking is another observing situation where remote telescopes are often useful. Many satellites are geosynchronous and will never appear in your sky, as their orbits are designed to stay over single spots on the Earth's surface. These can be imaged or tracked by radio remotely with equipment at the proper location.

Another reason for tracking satellites is that some may be confused with near-Earth objects because they are in solar or highly elliptical orbits. These are often rocket bodies or other debris from early launches. Project Pluto *(projectpluto.com/sat_eph.htm)* is an effort to determine and follow some of these very high orbit objects so that they are not using up valuable survey effort and can be discounted as a threat to the Earth.

Remote telescopes have also been useful, at least in my case, in identifying objects that are listed in the ISON (International Scientific Optical Network) catalog but are not listed in the U.S. Space Command catalog (Space-Track). This goes beyond just classified satellites, although those do appear in that list. I'm more interested in the ones that are not matched with a classified payload but are indeed tracked by one system and not matched to another. I recently published my final version of this study, which I performed over a period of nearly three years.

COMETS

Comets are notorious for being on the other side of the world from where you are when they're at their best. This is another way that remote imaging may be useful to you, as you may be able to find a telescope that has a better view of the comet you can't see well or at all from your home site. As a bonus, you can always report data on the comet to the COBS (Comet Observation Database) and add to our knowledge of comets through citizen science.

ACKNOWLEDGEMENT AND THANKS

Most citizen science work I've done over the last six years has been using a telescope at the Perth Observatory in Western Australia. They have been highly supportive of all my efforts and continue to help me and their other research partners throughout the world to add to our knowledge of the universe. ✶

Brad Young is Astronomical League Platinum Level Observer #1

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It's All About the Moon!

AN INTERVIEW WITH A NEW CLUB MEMBER INTERESTED IN LUNAR PHOTOGRAPHY

The Moonstruck Astronomy Club, a member of the Astronomical League, is active at On Top of the World, a 55+ community in Ocala, Florida. The club holds monthly meetings for the 72 men and women who are members of the club to discuss topics in astronomy and to feature presentations by guest speakers and club members about telescopes, observing, and the heavens. When the weather allows, the club hosts evening observation sessions for its members, some of whom bring their own telescopes to share views with others. The club also maintains a small "telescope lending library" from which members may "check out" a scope for weeks or months to use on their own.

Dean Rehpohl with the 8-inch Dobsonian

This article is an interview conducted by Moonstruck Astronomy Club reporter Jim Shuman with new club member Dean Rehpohl about his initiation into lunar photography.

Jim: How did your interest in the Moon begin, Dean?

Dean: While visiting our eight-year-old grandson in Minnesota, my wife and I gave him a used 90 mm Bushnell refracting telescope. And on Tuesday August 31, 2021, for the first time in my life, I viewed our Moon through a telescope. I was moonstruck! The hair on my arms and neck came to attention! My first thought was, "I've never seen such a magnificent thing in the Universe!" I knew I wanted to see more of it!

Jim: How did you land on a Dobsonian?

Dean: After seeing the Moon for the first time through a telescope, I immediately spent hours and weeks watching YouTube videos such as "Viewing Our Moon," "Best Beginner Telescopes," and "How to Photograph the Moon." I also searched the Internet to find dealers, prices, and availability of various telescopes I felt could best serve my needs and budget. I decided that an 8-inch Dobsonian reflector would be a great place to start for a novice. But to my disappointment, I soon found out that ALL the 8-inch Dobsonians were out of stock everywhere, and no one had any idea when they would be restocked. It was sad because that was the model I had decided I needed.

Jim: So, what did you do?

Dean: Shortly after that, I realized for the first time that the 55+ community where we had lived for nine years (On Top of the World in Ocala, Florida) has an astronomy club with a website *(moonstruckastronomyclub.org)*. We flew home from Minnesota on October 12, 2021, just in time for me to attend the next club meeting on October 14. I was so excited to be there; I didn't attend as a "visitor" but just paid my yearly membership fee as I came in the door and joined up as a member immediately!

During that meeting the club officers mentioned that they had six "loaner" telescopes and one was an 8-inch Sky-Watcher Dobsonian reflector! My hand shot up into the air. "I'll take that one!" (Talk about an answer to prayer! I didn't even know that they had a telescope lending library!) The next morning, one of the club officers dropped the telescope off at my house, gave me a quick overview, and answered my many questions. Later, I built a wood and foam cradle that supports the tube section of the scope for transport in my Kia Soul or on my golf cart.

Jim: How did you do at your first evening observation with the club?

Dean: That first time out after dark on a club observing event was really something! Here I was trying to impersonate an amateur astronomer and I didn't have any background or experience other than YouTube! But the club members assisted me with the Dobsonian, and soon I owned the Moon. I quickly realized that it was easy to manipulate the telescope, and the Moon was amazing and super beautiful. I was hooked! The scope worked great, although I had difficulty taking photos through the eyepiece with my handheld smartphone.

Jim: Then what...?

Dean: In the following days, I built a wooden stand to get my Dobsonian up off the ground, purchased a Celestron NexYZ smartphone adapter for my Pixel 3a smartphone, and started taking photos of my beloved Moon. Most of my observation time and Moon photography is done close to my home and during the day. (Yes, that's right. I said "day!") I would load up my golf cart, drive two blocks to an open grassy area in the community, and set up the Dobsonian – which has no problem capturing a clear image of the bright Moon on a sunny day. My neighbors, community vendors, and service people, whether walking

Crescent Moon by Dean Rehpohl – taken with Pixel 3a cell phone and an 8-inch Dobsonian

or driving by, would stop and ask, "What are you looking at during the day?" I would invite them to see my Moon! Then I would stand back and eagerly await their amazed reactions. At that point, I would tell them about my Moon, my loaner telescope, and the date and time of our next Moonstruck Astronomy Club meeting! This was getting really good, and my photographs were much better now that I had the adapter for my smartphone.

Jim: That's great, Dean! How do you go about getting really good photos of the Moon?

Dean: I now use the Astrospheric app to find the best days and nights for viewing

Quarter Moon by Dean Rehpohl – taken with Pixel 3a cell phone and an 8-inch Dobsonian

(not too many here in Florida), and I use the Moon Locator app to find out when, where, and what the Moon phase will be on any given day. I prefer to get photos where the terminator creates more shadows on the crescent or quarter Moon – it's more dramatic.

Jim: Any final words?

Dean: Many astronomers may think that my Moon is a hindrance to their deep-sky observations, but to me it is the frosting on my sky cake, my first solar love, and one of the greatest creations in the Universe! I have really loved the experience of photographing the Moon with the club's loaner Dobsonian reflector! ✶

LUNAR CLAIR-OBSCUR

By Cindy L. Krach

On the evening of October 5, 2022, my 12.5-inch reflector was focused on the Moon with no particular place to go, and there it was, Cassini's Moon Maiden, with her flowing hair and face pointed into Sinus Iridum. It was really quite breathtaking in its appearance and remarkable in its resemblance to just that, a woman with flowing hair, much like a mermaid looking out over her tail. I have wanted to observe and sketch this *clair-obscur* effect for some time but always seem to miss it.

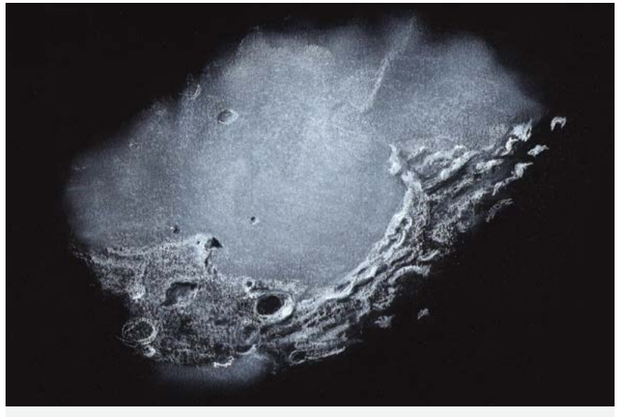
Lunar clair-obscur is a phenomenon of seeing something that appears familiar, an illusion of light and dark playing on craters and other lunar features, usually at the terminator. Our brains have us see something else, much like seeing shapes in clouds. The term clair-obscur is from the time of Renaissance French painters, translating to "light" and "shadow."

There are many such illusions on the Moon. A maiden's face, a jeweled or golden handle, and letters of the alphabet, to name just a few. These effects are short lived, sometimes only visible for hours. For the most part seeing must be excellent to observe many of them, but for the Moon Maiden poor seeing actually enhances the illusion. It softens the features, allowing the mind to fill in the gaps of information. The mountains on the terminator to the lunar west of Montes Jura become "hair," and Promontorium Hericlides becomes the "face."

These phenomena are informally named since the the IAU, or International Astronomical Union, responsible for naming astronomical features such as stars and lunar craters, does not assign them names. You will often find different names for the same phenomenon. The illusions appear on specific lunation days, which is how most plan to observe them.

There are a couple of lists of many of these features. One is compiled by Mike Rowles of Cloudy Nights forum and another from the old wiki clair-obscur lunar page. You can also find a few listed in the excellent new guide, *Carpe Lunam, Observing the Moon: A Guide for the Astronomical League's Lunar Observing Programs* by John Goss, available in the Astronomical League Store.

How can you predict when to observe these phenomena? As previously mentioned, many of the objects have lunar days listed for when to best observe the effect during either lunar sunrise or sunset. This works well for phenomena that have longer visibility, but for objects like the Lunar X, which has a narrow 4-hour window of observability, you need more precision. Good news: Because this sighting is so popular, you can often find prediction schedules online, but for many of the other light phenomena you will need to do some digging yourself.



Cassini's Moon Maiden, October 6, 2022, 0645-0730 UT, 12.5-inch f/4.5 reflector, seeing Antoniadi III-IV/V, transparency 3/7. Sketched at the eyepiece, black Artagain paper, white and black charcoal.

So what parameters would you need to know in order to arrive at the same lighting pattern again with any consistency? Locating the phenomena by lunar day is a start but can it be narrowed down further? Lunar software such as the free Virtual Moon Atlas can provide other important ephemeris information such as selenographic colongitude. Colongitude describes the exact position of the morning terminator, which is measured in degrees west of the central meridian of the Moon. However, this works best for objects located near the lunar equator and gets more imprecise moving out to the poles. Adding the Sun's angle for prediction helps, but then what about libration, the Moon's wobble? The pattern of libration actually changes from month to month and is not coupled to the lunar phase. The exact angle of the Sun created by libration is in fact repeatable, but only after each Saros, or 18 years, 10 days, 8 hours! So trying to find these events without some help is tricky to say the least. The movement of the Moon is pretty complex.

When required, the exact lighting can in fact be simulated and searched for with a program called *Lunar Terminator Visualization Tool (LTVT),* a free download created by Jim Moser and Henrik Bondo.* John Moore, also a contributor, has written a book about all the features the program offers. One of the features that make this so useful for clair-obscur objects is that the program very accurately shows what the lighting will look like on the terminator for any given UT date/time. Once you know the time in UT for one of these events you can predict future events, the program finding the identical lighting pattern. The program takes into account your location, selenographic colongitude, subsolar point, and libration. It's a powerful tool for locating these transient objects.

And then again, you can just wing it as I did for the sketch. Look to see if any of these interesting plays of light are visible when you're out observing the Moon. Once you start looking for these tricks of the light, your mind continues to find more of them. So as you observe the Moon maybe you will also come up with your own creations. If so sketch, photograph and share them! ✶

Cindy Krach is a member of the Haleakala Amateur Astronomers and is Astronomical League Sketching Observing Program Coordinator

Interested readers can email the author (alastrosketch@gmail.com) for the Mike Rowles spreadsheet file, information on John Moore's book, and links to the LTVT download.

Observing Awards

Active Galactic Nuclei Observing Program

No. 28-V, **Jeffrey Corder,** Ancient City Astronomy Club; No. 29-V, **Kevin Nasal,** Minnesota Astronomical Society; No. 30-I, **Mark Simonson,** Everett Astronomical Society

Advanced Binocular Double Star Observing Program

No. 47, **Siddhesh Mukerji,** Vermont Astronomical Society; No. 48, **Stephen R. Hildenbrandt,** Miami Valley Astronomical Society

Alternate Constellations Observing Program

No. 13-G, **Eric Edwards,** Albuquerque Astronomical Society; No. 14-S, **Eric Edwards,** Albuquerque Astronomical Society

Analemma Observing Program

No. 21, **Brad Schaefer,** Tucson Amateur Astronomy Association

Arp Peculiar Galaxies Northern Observing Program

No. 114-V, **Bill Hennessy,** Neville Public Museum Astronomical Society

Asterism Observing Program

No. 72, **Pete Hermes,** Tucson Amateur Astronomy Association; No. 73, **Rick Ginanni,** Greater Hazleton Area Astronomical Society

Asteroid Observing Program

No. 72, **Diane Ketchum,** Gold, Middle Georgia Astronomical Society

Bennett Observing Program

No. 1, **W. Maynard Pittendreigh,** Lifetime Member

Beyond Polaris Observing Program

No. 59, **Krista Lemoine,** Salt Lake Astronomical Society; No. 60, **Joseph Washburn,** Member-at-Large; No. 61, **James D. Anderson,** Astronomical Society of Kansas City

Binocular Double Star Observing Program

No. 198, **Jill Sinkwich,** Member-at-Large; No. 199, **Siddhesh Mukerji,** Vermont Astronomical Society; No. 200, **Michael K. Roberts,** Midlands Astronomy Club; No. 201, **Veronica L. Lane,** Ancient City Astronomy Club; No. 202, **Keith Norton,** Tucson Amateur Astronomy Association

Binocular Messier Observing Program

No. 1237, **Jonathan Cross,** Seattle Astronomical Society; No. 1238, **Siddhesh Mukerji,** Vermont Astronomical Society; No. 1239, **Trena Johnson,** Minnesota Astronomical Society; No. 1240, **Scott Sudhoff,** Wabash Valley Astronomical Society; No. 1241, **Kevin A. Wilson,** Member-at-Large; No. 1242, **Brent Knight,** Escambia Amateur Astronomers Association; No. 1243, **Gary Davis,** Member-at-Large

Bright Nebula Observing Program

No. 31, **Jeffery Corder,** Advanced, Ancient City Astronomical Club

Carbon Star Observing Program

No. 141, **Cindy Krach,** Haleakala Amateur Astronomers; No. 142, **Peter Berbee,** Patron Member; No. 143, **Clayton Jeter,** Member-at-Large; No. 144, **Edward Swaim,** Central Arkansas Astronomical Society

Citizen Science Special Program

Dan Crowson, Astronomical Society of Eastern Missouri, Jovian Vortex Hunter, Active Bronze; **Dan Crowson,** Astronomical Society of Eastern Missouri, Active Asteroids, Gold Class 17, 18, 19, 20, 21, 22, 23; **Pete Hermes,** Tucson Amateur Astronomy Association, Exoplanet Explorers, Active Gold Class 20; **Pete Hermes,** Tucson Amateur Astronomy Association, Galaxy Zoo, Active Gold Class 12; **Rich Krahling,** Richland Astronomical Society, Jovian Vortex Hunter, Active Bronze; **Al Lamperti,** Delaware Valley Amateur Astronomers, Star Notes, Active Gold Class 99; **Al Lamperti,** Delaware Valley Amateur Astronomers, Active Asteroids, Active Gold Class 68; **W. Maynard Pittendreigh,** Lifetime Member, Jovian Vortex Hunter, Active Bronze; **W. Maynard Pittendreigh,** Lifetime Member, Cloudspotting on Mars, Active Bronze; **W. Maynard Pittendreigh,** Lifetime Member, Variable Stars, Observational Gold Class 1

Comet Observing Program

No. 127, **David Babb,** Silver, Member-at-Large; No. 128, **Richard Bryant,** Silver, Bartlesville Astronomical Society; No. 129, **Anas Sawallha,** Silver, Member-at-Large

Constellation Hunter Northern Skies Observing Program

No. 286, **Carolyn Chrisman,** Roanoke Valley Astronomical Society; No. 287, **Carolyn Mirich,** Member-at-Large; No. 288, **Richard Bryant,** Bartlesville Astronomy Society; No. 289, **Trena Johnson,** Minnesota Astronomical Society; No. 290, **Krista Lemoine,** Salt Lake Astronomical Society

Deep Sky Binocular Observing Program

No. 441, **Gary Davis,** Member-at-Large

Double Star Observing Program

No. 696, **Joe Comiskey,** Kalamazoo Astronomic al Society; No. 697, **Trena Johnson,** Minnesota Astronomical Society

Flat Galaxy Observing Program

No. 45-I, Regular, **Mark L. Mitchell,** Delaware Astronomical Society; No. 46, Honorary, **Alfred Schovanez,** Astronomical Society of Eastern Missouri

Foundations of Imaging Observing Program

No. 6, **Herb Steck,** Astronomical Society of Eastern Missouri

Galaxy Observing Challenge

James Amis, Barnard Astronomical Society; **Steve Boerner,** Member-at-Large; **Brett Boller,** Prairie Astronomy Club; **David Brandt,** Barnard Astronomical Society; **Scott D. Cadwallader,** Baton Rouge Astronomical Society; **Richard Clements,** Barnard Astronomical Society; **Aaron Clevenson,** North Houston Astronomy Club; **Mike Colliver,** South Shore Astronomical Society; **Tom Conley,** North Houston Astronomy Club; **Dan Crowson,** Astronomical Society of Eastern Missouri; **Dan Delzell,** Prairie Astronomy Club; **David Dickinson,** Prairie Astronomy Club; **David Earnst,** Buffalo Astronomical Association; **Rick Ginanni,** Greater Hazleton Area Astronomical Society; **Matt Harbison,** Barnard Astronomical Society; **Harold Harris,** Barnard Astronomical Society; **Jeff Hart,** Austin Astronomical Society; **Pete Hermes,** Tucson Amateur Astronomy Association; **Gideon Johnson,** Prairie Astronomy Club; **Jenny Jo Johnson,** Prairie Astronomy Club; **Joy Ruth Johnson,** Prairie Astronomy Club; **Jim Kvasnicka,** Prairie Astronomy Club; **Veronica Lane,** Northeast Florida Astronomical Society; **Mike McCabe,** South Shore Astronomical Society; **Ralph McConnell,** Barnard Astronomical Society; **Robert Moore,** North Houston Astronomy Club; **Mike Napper,** Northeast Florida Astronomical Society; **Rick Palmer,** Buffalo Astronomical Association; **Ralph Pass,** Independent; **Russell F. Pinizzotto,** Southern Maine Astronomers; **W. Maynard Pittendreigh,** Lifetime Member; **Rick Ray,** North Houston Astronomy Club; **Gene Riggs,** Salt Lake Astronomical Society; **Jim Rutledge,** South Shore Astronomical Society; **John Sadler,** Barnard Astronomical Society; **Starla Schleicher,** Prairie Astronomy Club; **Alfred Schovanez,** Astronomical Society of Eastern Missouri; **Mark Simonson,** Everett Astronomical Society; **Katy Stewart,** Barnard Astronomical Society; **Dave Tosteson,** Minnesota Astronomical Society; **Andy Walker,** Astronomical Society of Eastern Missouri; **Raymond David Whatley,** Northeast Florida Astronomical Society; **Richard Wheeler,** Northeast Florida Astronomical Society; **David Wood,** Astronomical Society of Eastern Missouri

Galaxy Groups and Clusters Observing Program

No. 52-M/V, **Bob Vickers,** West Kentucky Amateur Astronomers

Galileo Observing Program

No. 67-B, **Paul Harrington,** Member-at-large; No. 68-T, **Dan Posey,** Hill Country Astronomers; No. 69-B, **Jim Hontas,** Cincinnati Astronomical Society; No 70-T, **Paul Runkle,** Chapel Hill Astronomical and Observational Society; Nos. 71-B and 71-T, **Eric Edwards,** Albuquerque Astronomical Society; No 72-B, **Brad Payne,** Northern Virginia Astronomy Club Society; Nos. 73-B and 73-T, **Dave Tosteson,** Minnesota Astronomical Society; No. 74-B, **Jeffrey Corder,** Ancient City Astronomy Club; No 75-B, **Bernard Vanasse,** Lifetime Member; No. 76-B, **Andrew Corkill,** Lifetime Member; Nos. 77-B and 77-T, **Mark Colwell,** Member-at-Large; No. 78-B, **Stephen J. Nugent,** Member-at-Large

Globular Cluster Observing Program

No. 381-V, **Keith Lawrence,** Vermont Astronomical Society; No. 382-V, **Larry Elsom,** Member-at-Large; No. 383-I, **John Sayers,** Member-at-Large; No. 384-I, **Albert E. Smith,** Member-at-Large; No. 385-V, **Stephen Pavela,** La Crosse Area Astronomical Society; No. 386-I, **Laurie V. Ansorge,** Lifetime Member

Herschel 400 Observing Program

No. 649, **Kevin Mayock,** Tucson Amateur Astronomy Association; No. 650, **Brent Knight,** Escambia Amateur Astronomers Association; No. 651, **Russell F. Pinizzotto,** Southern Maine Astronomers

Herschel Society Special Observing Program

No. 17, **Terry Trees,** Amateur Astronomers Association of Pittsburgh, Silver; No. 18, **Mark Bailey,** Member-at-Large, Silver

Hydrogen Alpha Solar Observing Program

No. 62-V, **Neil Perlin,** Member-at-Large; No. 63-V, **Lisa Wentzel,** Twin City Amateur Astronomers; No. 64-I, **Jeffrey Corder,** Ancient City Astronomy Club

Library Telescope Program

No. 26, **John Zimitsch,** Silver, Minnesota Astronomical Society

Lunar Observing Program

No. 1183-B, **Steve Sweeney,** Northern Cross Science Foundation; Nos. 1184 amd 1184-B, **David Woolf,** Kalamazoo Astronomical Society; No. 1185-B, **Mark Colwell,** Member-at-Large; No. 1186, **Michael Corvese,** Skyscrapers, Inc.; Nos. 1187, 1187-I, and 1187-B, **Anas Sawallha,** Member-at-Large; No. 1188-B, **Jeffrey Corder,** Ancient City Astronomy Club; No. 1189, **Jeremy Mullican,** Lifetime Member

Lunar II Observing Program

No. 130, **Dave Wickholm,** San Antonio Astronomical Association

Mars Observing Program

No. 14-I, **Dan Crowson,** Astronomical Society of Eastern Missouri

Messier Observing Program

No. 2882, **Veronica Lane,** Honorary, Ancient City Astronomy Club; No. 2893, **Andy Walker,** Regular, Astronomical Society of Eastern Missouri; No. 2894, **Charles D. Fry,** Honorary, Astronomy Enthusiasts of Lancaster County; No. 2895, **John Galla,** Honorary, Astronomical Society of Eastern Missouri; No. 2896, **David Sandage,** Honorary, Rose City Astronomers; No. 2897, **Rick Ray,** Regular, North Houston Astronomy Club

Meteor Observing Program

No. 76, **Steven Sauerwein,** Honorary 77, Member-at-Large

Multiple Star Observing Program

No. 18, **Ryan Behrends,** Hill Country Astronomers

Open Clusters Observing Program

No. 107, **Keith Lawrence,** Vermont Astronomical Society; No. 108, **Paul Harrington,** Member-at-Large; No. 109, **Charles Martin**, Atlanta Astronomy Club

Outreach Special Program

No. 485-M, **Alan Sheidler,** Popular Astronomy Club; No. 624-M, **Sonali Deshmukh,** Omaha Astronomical Society; No. 1006-M, **Mike Reitmajer,** Rose City Astronomers; No. 1028-M, **Claude Plymate,** Bear Valley Springs Astronomy Club; No. 1126-M, **Bradley Nasset,** Minnesota Astronomical Society; No. 1135-S, **Barton Meeks,** Raleigh Astronomy Club; No. 1261-O, **Rob Parsons,** Raleigh Astronomy Club; No. 1262-O, **Ralph E. McConnell,** Barnard Astronomical Society of Chattanooga; Nos. 1263-O, 1263-S, and 1263-M, **Donna Barnes,** Astronomical Society of Eastern Missouri; Nos. 1264-O, 1264-S, and 1264-M, **Lisa Barnes,** Astronomical Society of Eastern Missouri; No. 1265-O, **Dave Wood,** Astronomical Society of Eastern Missouri; No. 1266-O, **Karey Todd,** Astronomical Society of Eastern Missouri; No. 1267-O, **Don Ladwig,** Astronomical Society of Eastern Missouri; Nos. 1268-O and 1268-S, **Jim Stenzel,** Astronomical Society of Eastern Missouri; No. 1269-O, **Kirk Steinbruegge,** Astronomical Society of Eastern Missouri; Nos. 1270-O and 1270-S, **Krista Lemoine,** Salt Lake Astronomical Society; No. 1271-O, **Ben Eisenstein,** Tucson Amateur Astronomy Association; Nos. 1272-O and 1272-S, **Tim Lawler,** Tucson Amateur Astronomy Association; Nos. 1273-O and 1273-S, **Sam Miller,** Tucson Amateur Astronomy Association; Nos. 1274-O and 1274-S, **Robert Rose,** Tucson Amateur Astronomy Association; No. 1275-O, **David Rossetter,** Tucson Amateur Astronomy Association; No. 1276-O, **Gary Wells,** Tucson Amateur Astronomy Association; Nos. 1277-O, 1277-S, and 1277-M, **Barbara Whitehead,** Tucson Amateur Astronomy Association; Nos. 1278-O and 1278-S, **Viola Sanchez**, Albuquerque Astronomical Society; No. 1279-O, **Don Ladwig,** Astronomical Society of Eastern Missouri; No. 1280-O, **Jeff Bernth,** Astronomical Society of Eastern Missouri; No. 1281-O, **Justin Thompson,** Astronomical Society of Eastern Missouri; No. 1282-O, **Tan Nguyen,** Astronomical Society of Eastern Missouri; Nos. 1283-O and 1283-S, **Rick Palmer,** Buffalo Astronomical Association; No. 1284-O, **John A. Sheffey,** Roanoke Valley Astronomical Society; No. 1285-O, **Kristin Berry,** Astronomical Society of Eastern Missouri; No. 1286-O, **Tom Berry,** Astronomical Society of Eastern Missouri; Nos. 1287-O and 1287-S, **Bill Fisher,** Astronomical Society of Eastern Missouri; No. 1288-O, **Carl Turek,** Astronomical Society of Eastern Missouri; No. 1289-O, **Herb Steck,** Astronomical Society Eastern Missouri; No. 1290-O, **David Stone,** Flint River Astronomy Club; No. 1291-O, **Rosanne Stone,** Flint River Astronomy Club; No. 1292-O, **Wade Simmons,** Flint River Astronomy Club; No. 1293-O, **Carl Turek,** Astronomical Society of Eastern Missouri; No. 1294-O, **Dana R. Bostic,** Raleigh Astronomy Club

Planetary Nebula Observing Program

No. 99, **Sean Smith,** Advanced Manual, Denver Astronomical Society; No. 100, **David Hasenauer,** Advanced Manual, Texas Astronomical Society of Dallas; No. 101, **Larry Bloom,** Advanced, Longmont Astronomical Society

Radio Astronomy Observing Program

No. 37-B, **Marie Lott,** Atlanta Astronomy Club; No. 38-B, **Dave Lacko,** Member-at-Large

Sketching Observing Program

No. 57, **Viola Sanchez,** Albuquerque Astronomical Society

Solar Neighborhood Observing Program

No. 1 (Eyes Only), **W. Maynard Pittendreigh,** Lifetime Member; No. 2 (Eyes Only), **Steve Boerner,** Member-at-Large; No. 3 (Eyes Only), **Aaron Clevenson,** North Houston Astronomy Club; No. 4 (Eyes Only), **Marie Lott,** Atlanta Astronomy Club; No. 5 (Eyes Only), **Michael A. Hotka,** Longmont Astronomical Society; No. 1 (Binocular), **Steve Boerner,** Member-at-Large

Solar System Observing Program

No. 205-B, **Stephen Pavela,** La Crosse Area Astronomical Society

Spectroscopy Observing Program

No. 2, **Antone G. Gregory,** Minnesota Astronomical Society; No. 3, **Michael A. Hotka,** Longmont Astronomical Society

Sunspotter Observing Program

No. 201-I, **Brad Payne,** Northern Virginia Astronomy Club; No. 216, **Jonathan Poppele,** Minnesota Astronomical Society; No. 217, **Sean Smith,** Denver Astronomical Society

Two in the View Observing Program

No. 53, **Lisa Wentzel,** Twin City Amateur Astronomers; No. 54, **Lario Yerino,** Astronomical Society of Kansas City

Variable Star Observing Program

No. 56, **Andrew Corkill,** Lifetime Member

Master Observer Progression

OBSERVER AWARD

Andrew Corkill, Lifetime Member

BINOCULAR MASTER AWARD

Andrew Corkill, Lifetime Member

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