Published by the Astronomical League
Vol. 75, No. 4 SEPTEMBER 2023

Reflector

LEAGUE AWARDS FOR 2023

THE DEER LICK GALAXY GROUP

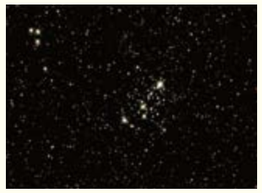
THE CASE OF THE MISSING MATTER

DWARF NOVAE

EDWIN HUBBLE

Contents

PAGE 9



PAGE 16

PAGE 25

4. . . . . .To the Editor
4. . . . . .Star Beams
5. . . . . .DarkSky
5. . . . . .Night Sky Network
6. . . . . .Full STEAM Ahead
7. . . . . .Wanderers in the Neighborhood
8. . . . . .Deep-Sky Objects
10. . . . . .Around the league
11. . . . . .League Awards
17. . . . . .Astronomy Super Bloom
19. . . . . .The Deer Lick Galaxy Group and Deerlick Gap Overlook
20. . . . . .Dwarf Novae
22. . . . . .Edwin Hubble, The Surveyor of the Universe
24. . . . . .The Case of the Missing Matter
26. . . . . .Gallery
30. . . . . .Observing Awards

Bernard Miller *(East Valley Astronomy Club) captured this image of NGC 6015 with a PlaneWave 17-inch CDK and an FLI 16803 CCD camera from his observatory in Animas, New Mexico. The image is shown cropped. Image ©2022 Bernard Miller.*

Reflector

The Astronomical League Magazine

Vol. 75, No. 4 • ISSN: 0034-2963 • SEPTEMBER 2023

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

Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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

PAPER SUBSCRIPTIONS:

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

DIGITAL SUBSCRIPTIONS:

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

***REFLECTOR* AND CLUB ROSTER DEADLINES**

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

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

To the Editor

As Leslie Peltier states so eloquently in chapter 9 of his book *Starlight Nights*, "A variable star was a completely new experience; it was not just something that was there; it was something that was happening!" Jamey Jenkins, in "Further Adventures of a Starlight Detective" (*Reflector*, June 2023) has shown how you can follow brightness variations using CCD or CMOS cameras and special software, but you do not need such equipment. You do not even need a telescope! You can see some stars change brightness with your unaided eye!

For example, Beta Persei, Algol ("the eye of the demon") "winks" at you over the span of a few hours every 2.867 days (68.8 hours). Omicron Ceti, Mira, "miraculously" brightens slowly, reaches maximum brightness (when it is visible to the unaided eye), and fades slowly back to obscurity over the course of a season. You can follow dozens more with simple binoculars. You can watch hundreds with even a small telescope. Some will brighten, but then fluctuate as they fade, seeming to heed Dylan Thomas's urging, "Do not go gentle into that good night." What's going on? What's *happening?*

Astronomers have numerous theories for the astrophysics of variable stars, but to determine which theory applies to which stars, they need data. You can help provide that data. Using the photometer we all have, our eyes, you can, with a little practice, provide valuable estimates of a star's brightness at a given time. Reporting those estimates to an organization like the American Association of Variable Star Observers (AAVSO) helps build a database from which astronomers can test their theories.

It is easy to get started. Try the League's Variable Star Observing Program or visit the AAVSO webpage *aavso.org/online-resources* for beginner instructions. Is it clear tonight? Go watch things *happen*!

—Jim Fox
Astronomical League president 1990–1994

Before my parents and the neighbors placed floodlights on their houses, I would walk to the middle of the backyard and lay on the grass. My child eyes were focused on the many stars, as the tree leaves rustled behind me. I knew nothing of the Bortle scale. There were no thoughts of pill bugs (roly-polies), ants, worms, or snails, just the visual of the twinkling lights dancing to the chorus of cicadas and crickets.

When I moved to the city as an adult, the sky was awash with lights. Even though the backyard was filled with trees and was dark enough to see the many fireflies, the city lights hid the stars from me. So, I wrote a poem to express my feelings.

STATE OF MINE

With my schedule in my head,
The sun breaks through the darkness
One second at a time.
Each minute outlines
Shadows of dark green which hides beneath
Pine and magnolia leaves.

The sun climbs to its apex
Chasing the darkness,
Genuflecting for the night,
Accepting the moons right
To a pomp amid the
Fashionably late stars.

—Pearl (Pearlie Harris)

Star Beams

NEW ASTRONOMY DAY COORDINATOR

I am pleased to announce the appointment of Mike Modrcin as the new Astronomy Day coordinator.

Mike Modrcin is a Nebraska native and a member of the Omaha Astronomical Society, where he currently serves as outreach co-chairperson. He inherited his interest in science from his father, who taught high school science for 40 years. While he enjoys all things astronomical, he often considers outreach to be his actual hobby.

photo courtesy Mike Modrcin

He loves participating in star parties and other outreach events where he can share the wonders of the night sky with others. His favorite part of outreach is watching the spark that lights up in the face of someone who has just seen the rings of Saturn or had 2.3-million-year-old photons bounce off their eyeball for the first time. He is eager to dive in and help grow the Astronomy Day program.

Mike is part of the Library Telescope Task Force and actively promotes the Library Telescope Program in Nebraska and Iowa. He is also the vice chair of an upcoming MSRAL convention planning committee and a NASA Partner Eclipse Ambassador. His favorite deep-sky objects are galaxies and planetary nebulae. He has an interest in amateur telescope making, having completed a 10-inch Dobsonian last year, and is now working on rebuilding an old 16-inch Meade reflector. While not staring at the stars, he enjoys cooking, gardening, and camping with his wife and three dogs.

Gary Tomlinson has been the steady hand that has guided the Astronomical League's Astronomy Day activities for the past 40 years. Whether Gary was doing the administrative work or making sure

photo courtesy Great Lakes Planetarium Association

the Astronomy Day events were publicized and submissions were judged, he was always there to ensure that the program stayed active.

Among Gary's many achievements, he was instrumental in scheduling a regional-type "mini" event honoring our Astronomical League award winners who were unable to travel to ALCon in 2013 to receive their awards in person. This was held at the Grand Rapids Public Museum's Chaffee Planetarium, with which Gary was affiliated. At that event, an Astronomy Day award was presented to Alan Sheidler, at that time vice president of the Popular Astronomy Club, and now the newly elected chair of NCRAL. At that event where we brought the League awards to the people in that area, an NYAA award was presented in addition to other League awards. **Thank you, Gary, for your many years of outstanding service to the Astronomical League!**

CALL FOR SPONSORSHIPS OF LEAGUE AWARDS

Have you considered establishing an Astronomical League award sponsorship as part of your financial planning? Perhaps you are looking for a tax-free way of meeting your required minimum distribution amount from your tax-deferred retirement plan. Now is your opportunity to do this, while helping the Astronomical League with this educational mission of recognizing astronomers who have made valuable contributions.

Sponsorship opportunities include the Jack Horkheimer suite of youth programs (Smith Service Award, the Youth Imaging Awards, Youth Journalism Award, etc.). Other opportunities for your sponsorship include the Library Telescope Program that awards a telescope to a library in each of our regions and to one member-at-large for establishing a program with a local library. Additional opportunities for sponsorship include the Mabel Sterns Newsletter Award and the Webmaster Award.

Please contact me at *president@astroleague.org* if you would like to contribute in any of these most meaningful ways. Please consult with your own professional legal and financial consultants before setting up a giving program, since the Astronomical League doesn't offer that type of expertise.

ESTATE PLANNING AS A WAY OF GIVING BACK TO THE ASTRONOMICAL LEAGUE

For over 75 years, the Astronomical League has been the major voice for amateur astronomy in the country and internationally. If you are looking for a lasting way of giving back to the League, your estate planning is an excellent way of helping the League to continue and expand our educational mission. For more information on setting this up, please contact me at *president@astroleague.org*.

—Carroll Iorg, President

DarkSky (IDA)

IDA HAS A NEW NAME AND LOGO!

For the past year, the board of directors and staff of the International Dark-Sky Association (IDA) worked closely with a consultant to refine the brand. The board chose to change the name from International Dark-Sky Association to **DarkSky**. I personally have mixed feelings about the name change. For the past 30+ years I have been used to the name and the abbreviation IDA. Also, I was the one who came up with the name and abbreviation. Oh well – times change, and we need to step up our efforts to fight light pollution, which is worsening at a worrisome rate, as I noted in my last *Reflector* column.

International Dark-Sky Association is a somewhat clumsy name when discussing light pollution with a newcomer, and DarkSky has really been used by IDA since its early days, as its web address is *www.darksky.org*. The designer of the new DarkSky logo is Mark Bult, who conducted research, sent a survey to the entire membership, and received nearly 1,000 responses from 69 countries. This research and survey showed that many people felt the term DarkSky was professional, scientific, welcoming, and trusted.

However, in many places the terms *dark, dark sky,* and so forth may have negative connotations. Dark can be equated with unsafe. This connotation has been an issue since the founding of the organization. Nevertheless, we really want dark skies not only for our own astronomical pursuits but for the betterment of the environment. Interestingly, one issue with the original name was when to use the hyphen in "Dark-Sky." I must admit, I hyphenated the name so the abbreviation IDA would work out well.

The new name DarkSky is felt to retain the existing "brand equity" with it merely being shortened a bit from before. Board president Tom Reinert is credited with suggesting the new name. Check out the discussion about the name change and see the new logo at *www.darksky.org/we-have-a-new-name-and-logo*. Look at the IDA logos over the years from 1988 to 2022 and compare them with the new DarkSky logo.

—Tim Hunter
Co-founder of IDA,
now known as ***DarkSky***

Night Sky Network

NASA SUPPORTS ECLIPSE ENGAGEMENT

Get ready for the "warm up" annular solar eclipse on Saturday, October 14. It will be visible as a partial eclipse across the entire contiguous United States and as a beautiful ring of fire on a narrow path from Oregon through Texas. Billed as the opening act for the total solar eclipse happening just six months later on Monday, April 8, this is a great chance to get your community excited about our place in space and remind them

The South Florida Amateur Astronomers welcomed more than 5,000 visitors for the partial eclipse seen there in 2017. Credit: Emilee Rose

to take a moment and look up.

NASA has many resources to support events big and small. Most of the U.S. will experience a partial eclipse, and if you'd like to throw a party in your community (or know a group that would), this one-page handout gives you everything you'll need to get set up: *bit.ly/partialeclipseparty*.

From safe solar viewing handouts and posters for your local schools to activities and 3-D printing files, NASA has you covered with resources to support your enjoyment of and engagement with the eclipses. For resources, start at *solarsystem.nasa.gov/eclipses*.

Want to share more with your community? Between the eclipses, get your community ready to observe (especially if you and your club will be gone when the shadows arrive) by partnering with an undergraduate to become an Eclipse Ambassador (*eclipseambassadors.org*). You'll be partnered, trained, and given loads of glasses and hands-on activities to share with your community *before* the April 8 total eclipse. There is no commitment during eclipses and a lot of ways to get involved.

Not enough eclipse for you? Participate in a citizen science project and collect temperature data for scientists via the GLOBE Eclipse app or study the ionosphere with ham radio: *science.nasa.gov/citizenscience*.

Not sure if your community will be excited about seeing "only" a partial eclipse? If you prepare them, they most definitely will be! So many of us went to the path of totality in 2017, but these pictures of parties under a partial eclipse show just how much fun folks had back home, too. Make sure you prepare your community before you take off for the shadows!

Wishing you clear skies for both eclipses, but even if there are clouds, NASA is partnering with the Exploratorium to offer live streaming from across the country (*exploratorium.edu/eclipse*).

—Vivian White

Full STEAM Ahead

STEM ON WHEELS

More and more schools, libraries, and public parks are hosting STEM or STEAM nights, and clubs all over the United States are more engaged than ever. In 2020, a NASA Solar System Ambassador with plans for public engagement in Tulsa, Oklahoma, was undertaking a project. In fact, she was planning to speak at MSRAL 2020, which unfortunately had to be canceled. Her project was a mobile observatory from the Science Heads organization that could visit schools, libraries, museums, and other organizations to conduct STEM activities. The concept is the brainstorm of Richard Stember, the executive director of Science Heads, whose mission is to get STEM activities into the school systems to encourage students to pursue science, technology, engineering, and mathematical careers.

After COVID, the woman stepped down, but the trailer needed to be finished before it could get out into the community. Richard sent out feelers to a local club who put my name forward, and the Broken Arrow Sidewalk Astronomers (BASWA) adopted the trailer; I was voted to replace the former chapter coordinator. The mission of Science Heads is remarkable, and as an avid outreacher, I saw the potential benefits to astronomy clubs and similar groups. It is my hope that this project will help restore membership numbers to what they were prior to COVID, and bring in younger people into the clubs to stem the well-known "graying" of our hobby.

Science Heads chapters are volunteers from the community who are teachers, professionals, and amateurs that offer data-driven science, technology, engineering, and math sessions to students. The Northeast Oklahoma Mobile Observatory, formally the Tulsa Chapter, has the astronomy facet well covered with the current volunteer base, so Science Heads is helping to draw more people from the community. Thanks to their efforts, we now have a new NASA Solar System Ambassador and a young man interested in hosting technology activities. BASWA did a soft roll out at a nature park in Broken Arrow that is also interested in partnering on events. With a few minor details left to go, such as a wrap on the outside, still in the works, a ribbon cutting for school systems officials, educators, city and state officials, and media outlets is scheduled for August to let everyone know this resource is available for the new school year.

Each mobile observatory (MOB) contains a 6-foot fiberglass observatory dome, an 11-inch Celestron SCT or Meade equivalent, a pier mount, a Coronado 70 mm SolarMax III hydrogen-alpha solar scope, an ASO color and black-and-white USB camera, a laptop for NASA "Eyes on the Solar System" virtual tours, *slooh.com* real-time viewing via remote telescopes ("plan B" for cloudy nights), tracking and live views from the ISS, a Verizon Jetpack mobile Wi-Fi hotspot, and two interior 32-inch TV monitors. The goal is to have equipment for day or night events and information sessions ready for guests to experience as they wait for their turn at the eyepiece. With the Slooh software, hosting a session even on a cloudy night is a great plan B.

In addition, other aspects of STEM are hosted around the MOBs on tables to engage people in line for the observatory. Opening up these activities to other STEM fields will help to interest students in science more broadly. It will also give students a much richer experience.

To embark on this journey yourself, go to the Science Heads website at *scienceheads.org* and get an idea of the vision of this organization. There are floor plans and punch lists that can give one the idea of how to transform a trailer into an observatory. Funding is donation-based and Science Heads have personnel to review any grant that will be submitted for consideration.

Richard Stember spoke at the Mid-States convention in June and shared how the organization got started, his vision for reaching students, the aid Science Heads offers during this whole process, and plans for those who are not interested in forming a chapter but would simply like a mobile observatory. There are several clubs in the MSRAL that are interested, so I hope to be working with them in the near future. Any club or group with questions, regardless of your state or region, should feel free to contact me at *astroleague_steam@cox.net*.

Full STEAM ahead, with wheels!

—Peggy Walker,

Astronomical League STEAM and Junior Activities Coordinator

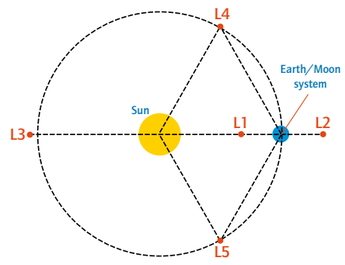
Wanderers in the Neighborhood

EARTH'S CLOUD MOONS

The James Webb Space Telescope (JWST) was launched on Christmas Day, 2021, on a European Space Agency Ariane 5 ECA launch vehicle. This heavy-lift launcher sent JWST on its way to an observing station almost a million miles beyond the Earth's orbit. There it will orbit the L2 Lagrangian point, far from the infrared glare of both the Earth and the Moon. This orbit avoids having either the Earth or Moon eclipse the Sun, which would cause temperature fluctuations in JWST's structure. This could cause the carefully calibrated aim of the mirror segments at the secondary mirror to be lost and force a recalibration. This orbit prevents the loss of valuable observing time on the telescope.

The L2 point, along with the other four Lagrangian points, exist in any system with three objects: a high-mass object, like the Sun; an intermediate mass object, like a planet; and a low-mass object, like an asteroid or spacecraft. At the Lagrangian points, the gravitational fields of the Sun and planet create equilibrium points where smaller objects can remain without being pulled toward the Sun or the planet. The most obvious example is the L1 point. It is located on the line between the planet and the Sun at the point near the planet where the planet's gravity counterbalances the opposing gravity of the sun. A small object at L1 will orbit the Sun with the same period as the planet, even though its location nearer the Sun should make it orbit faster than the planet.

In addition to L1, points L2 and L3 are also along the line that connects the sun and the planet. The L2 point where JWST orbits is on the opposite side of the planet from the Sun, where the combined gravity of the planet and Sun counterbalances the centrifugal effect on the object at the L2 point. This causes a body at L2 to orbit faster than it would for a body at that distance from the Sun, making its period the same as that of the planet.



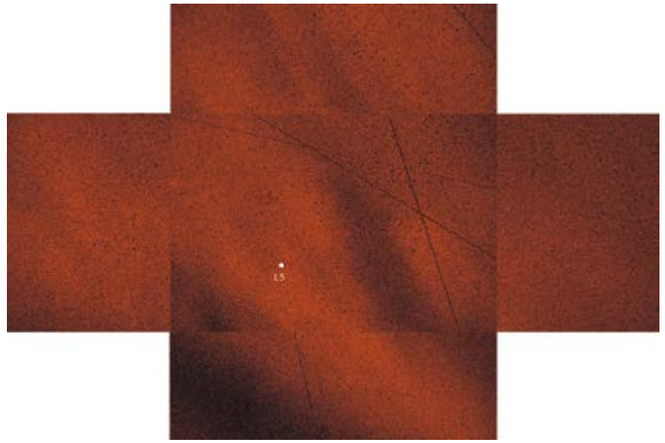
The five Lagrangian points are depicted here with the Sun and Earth providing the gravitational fields. The original three Lagrangian points discovered by Euler are the L1, L2, and L3 points. These collinear points are unstable and a small amount of work must be expended to stay in or orbit these locations. Objects at L4 and L5 tend to naturally oscillate around those points, such as the Trojan asteroids associated with Jupiter.

Also on the line between the sun and the planet is L3, which is on the far side of the sun from the planet. It is slightly beyond the distance that the planet orbits the sun because it feels the gravity of both the sun and the planet, so an object at L3 has to orbit slightly further from the Sun to have the same period as the planet.

These three collinear points were discovered by the Swiss mathematician Leonhard Euler around 1750 when he reformulated Isaac Newton's laws of mechanics. One of his students was Italian mathematician Joseph-Louis Lagrange. In his 1772 "Essay on the three-body problem," Lagrange showed that in addition to the three collinear equilibrium points, there were two more equilibrium points. These two new points, L4 and L5, each form the third vertex of an equilateral triangle with the Sun and planet. These two points are sixty degrees ahead of and behind the planet in its orbit around the Sun.

While it sounds like the Lagrangian points are a mathematical oddity, they have real effects on our Solar System. They provide convenient locations for satellites and space telescopes because these orbits can be maintained with limited corrections (see NASA reference). For example, the Wilkinson Microwave Anisotropy Probe orbited L2 starting in 2001 and the James Webb Space Telescope is currently parked in an orbit around L2.

These equilibrium points also serve as places for minor planets (asteroids) to congregate. For example, Jupiter, being near the asteroid belt, has collected asteroids associated with the L4 and L5 points. These asteroids belong to the Trojan asteroid family. Recalling the Trojan war from Greek history, the asteroids associated with L4 (sixty degrees ahead of Jupiter) belong to the Greek camp, while those associated with L5 (sixty degrees behind Jupiter) belong to the Trojan camp. More correctly, the Trojans oscillate around the L4 or L5 points, as Jupiter's gravity alternately applies a positive or negative acceleration on them as they orbit (see Davis reference). NASA's Lucy spacecraft is on its way to Jupiter-space to examine two main belt asteroids, four Greek-camp Trojan asteroids and two Trojan-camp Trojan asteroids over the next eleven years as part of its



The polarization pattern of dust around the L5 point (white dot) of the Earth–Moon system. The polarized light scattered by the dust clouds is represented as red pixels in these images. The imaging polarimeter took data in the green (550 nm) spectral range on August 19, 2017. The five panels of the mosaic represent an area about ten degrees high and fifteen degrees across. The dark straight lines are artificial satellite trails. Image Credit: J. Slíz-Balogh

primary mission. The extended mission may visit more of these Trojans.

Most of the planets of the Solar System have trojan asteroids at L4, L5, or both. The exceptions are Mercury and Saturn. Jupiter has the most, with over eleven thousand Trojans sharing its orbit. Earth has two known trojans, both at L4. They are minor planets 2010 TK_7 and (614689) 2020 XL_5. The first was discovered by the WISE spacecraft and it is about a quarter-mile across. The second was discovered by the Pan-STARRS 1 telescope and it is almost three-quarters of a mile across. Other asteroids may have passed through Earth's L4 and L5 points, but they were travelling too fast to be captured.

The Earth–Moon system also has Lagrangian points, with the Earth taking the role of the Sun and the Moon taking the role of the Earth. This puts an L4 point sixty degrees ahead of the Moon in its orbit and an L5 point sixty degrees behind the Moon. While these two Lagrangian points have not captured an asteroid, there may be dust trapped in these equilibrium points.

Dust in our Solar System generally collects in a pancake along the ecliptic. Sunlight is scattered by this dust and under very dark, clear skies, it can be seen hugging the ecliptic. Near the Sun, the dust reflects more sunlight, forming the zodiacal light, which appears along the ecliptic shortly after evening twilight ends and shortly before morning twilight begins. Another bright spot along the ecliptic is in the area on the opposite side of the Earth from the Sun. The dust there reflects more sunlight due to the backscatter effect to form the gegenschein or counterglow.

Over 230 years ago, it was theorized that with all of this dust in the Solar System, some of it could become trapped in the Earth–Moon L4 and L5 points, forming dust cloud moons orbiting the Earth. Unfortunately, they are very faint and astronomers did not prioritize observing them, so they were not observed. Polish astronomer Kazimierz Kordylewski started a search for them in 1956 and between March 6 and April 6, 1961, he photographed two bright patches that were virtually stationary relative to L5. These dusty regions were dubbed the Kordylewski clouds. Even so, some astronomers still doubted the existence of these dust cloud moons (see Kuligowska reference). They were observed again in 1967 by J. Wesley Simpson using the Kuiper Airborne Observatory. He made infrared observations of the clouds at L4 and L5 over a three-year period to determine the behavior of the dust particles at these libration points.

Visual observations of the Kordylewski clouds have been reported from time to time, always from very dark sites like deserts, oceans, or mountains. The clouds appear to be about six degrees in diameter with the brightness of the gegenschein, but they have a redder color. They can drift as much as ten degrees away from the Lagrangian points. Some observations have placed the clouds in an orbit around these points in ellipses of six by two degrees. The Japanese Hiten spacecraft passed through both L4 and L5 in 1992 on its way to lunar orbit. It did not find enhanced dust levels, but it only made one pass through each point, so it may have missed the dust clouds if they are orbiting the Lagrangian points.

In 2018, a Hungarian team, led by Gábor Horváth of Eötvös Loránd University, developed a model of the clouds' reflectance in polarized light, which was tested by imaging the area around the L5 point with camera lens and CCD camera at Judit Slíz-Balogh's private observatory in Hungary (Badacsonytördemic). As reported in the *Monthly Notices of the Royal Astronomical Society*, the team showed that their images recorded dust-reflected polarized light extending to the edges of the image and beyond. The observed pattern matched the predictions they had previously made. The results were also consistent with the original observations of the clouds made by Kordylewski in 1961. The new observations confirmed the existence of the clouds (see Massey reference).

Searches for additional solid moons of the Earth have not turned up any new candidates. Nevertheless, the Earth has more than one moon. The Moon that we all know is accompanied by two or more dust cloud moons keeping the Earth company as it orbits the Sun.

—Berton Stevens

REFERENCES:

Davis, J. (2018) "Exploring Jupiter's Trojan Asteroids." *Astronomy, www.astronomy.com/science/exploring-jupiters-trojan-asteroids.*

Kuligowska, Elžbieta (2018) "Kordylewski Clouds – Dust Moons of the Earth-Moon System." Astronomical Observatory of the Jagiellonian University, *www.oa.uj.edu.pl/AOM/aom18dec.en.html.*

Massey, R. (2018) "Earth's Dust Cloud Satellites Confirmed." *EurekAlert! www.eurekalert.org/news-releases/652221.*

NASA. (2021) "What are Lagrange Points? We Asked a NASA Scientist." YouTube, *www.youtube.com/watch?v=fTVN19h4nMg.*

Simpson, J.W. (1967) "Dust-cloud Moons of the Earth." *Physics Today, pubs.aip.org/physicstoday/article-abstract/20/2/39/425760/Dust-cloud-moons-of- the-earthTwo-naturally.*

Wang, P., et al. (2021) "Ground- and Space-based Observation of Kordylewski Clouds." *Space: Science & Technology, spj.science.org/doi/10.34133/2021/6597921.*

Deep-Sky Objects

JEWELS FOR THE QUEEN

Cassiopeia is a northerly constellation that is best viewed in the fall. In Greek mythology, Queen Cassiopeia is the wife of King Cepheus and the mother of Andromeda. Cepheus ruled over Aethiopia, the upper Nile region of Sudan.

Both Cepheus and Andromeda are constellations adjacent to Cassiopeia, so the entire mythological family is honored in the constellations. For Europe and most of North America, Cassiopeia is circumpolar – it never sets.

The Milky Way runs through the southern regions of Cassiopeia. This means the constellation is filled with myriad star clusters, double stars, and colorful nebulae. The brightest stars in the constellation are, from west to east, Caph, Shedar, Navi, Ruchbah, and Segin. These stars form the easily recognized W asterism.

One of the best galactic star clusters in Cassiopeia is M103. Charles Messier's colleague Pierre Mechain discovered M103 in 1781. M103 was the last object Messier added to his original catalog. An avid comet hunter, Messier created this catalog of fixed objects (that is, not moving against the background stars) he did not want to confuse with possible comets. Messier identified faint comets by their motion over the course of hours or days with respect to the stars. At the eyepiece of Messier's primitive 18th-century telescopes, Messier objects and faint comets all appeared as fuzzy patches.

M103 is easy to find. The star cluster is 1.5 degrees northeast of the star Ruchbah. With a combined magnitude of 7.4, the cluster can easily be seen in binoculars and 30–50 mm finderscopes from dark sites. In these small instruments, the cluster appears as a tiny fan-shaped patch. The cluster is about six arcminutes in size. M103 is thought to be 8,500 light-years away.

In larger telescopes, M103 is a loose collection of approximately 40 stars between magnitudes 8 and 12. The brightest star in the cluster is Struve 131 (HD9311 or SAO11822). This is a double star with components that are magnitudes 7.3 and 10.5 separated by 13 arcseconds. This pair is at the apex of the fan-shaped patch on the northern edge of the cluster. Despite its appearance, Struve 131 is not a physical member of the M103 star cluster. It is a foreground star, 1,700 light-years away. Similarly, all the stars brighter than magnitude 10 apparently in the cluster are also foreground stars.

The two brightest cluster members are both magnitude 10.5. One is a spectral class B5 supergiant and the other is a B5 giant star. They are both blue-white in color. The cluster also contains a magnitude 10.8 red giant star of spectral class M6.

M103 is also known as NGC 581. The cluster has a true diameter around 15 light-years and is thought to be 25 million years old. The cluster may contain up to 172 stars, most too faint to see with an 8-inch telescope.

The accompanying image of M103 shows how the cluster might appear in a 6- to 8-inch telescope from a dark site. The image was taken with an 8-inch f/8 Ritchey–Chrétien Cassegrain with a 0.8× focal reducer/field flattener using an SBIG STF-8300C CCD camera. The exposure was 60 minutes.

The brightest star in the image, near the center of the image at left, is Struve 131. The bright blue star near the bottom of the image is HD9303, a magnitude 7.6 spectral class A0 star. The bright orange star on the upper right side of the image is HD9146, a magnitude 8.1 K1 giant star. None of these stars are members of M103. The image captures stars down to magnitude 16.

M103 is one of many fascinating open star clusters in Cassiopeia. Because of Charles Messier, it has a richer history of observation than most. This fall, everyone needs to visit this star cluster while exploring the nighttime sky with binoculars and telescopes.

—Dr. James Dire

Around the League

INTRODUCING THREE NEW COUNCIL MEMBERS

BY CHUCK ALLEN

Please join me in welcoming three of our newest council members. Dena McClung and Bruce Bookout were appointed as chair and representative of the MARS Region at ALCon 2022. Alan Sheidler was elected chair of the Northwest Region in May 2023.

DENA MCCLUNG, MARS CHAIR

Dena McClung has been watching the night sky since she was a child growing up in a small town. Her father took her outside to look at the stars and the Milky Way. She followed the space program from Apollo onward and dreamed of becoming an astronaut but settled on becoming a private pilot and an FAA air traffic controller, retiring from the Denver Tower. She was unable to continue her astronomical pursuits during her career but had an exciting encounter with a brilliant meteor on a seeming collision path with her aircraft on a night flight.

After retiring, Dena joined the Denver Astronomical Society where she became an operator of the Chamberlin Observatory's 129-year-old 20-inch Clark-Saegmuller refractor. She currently serves as the club's president and previously served as secretary, membership coordinator, and vice president.

An avid reader, Dena has learned much about astronomy in books and online and shares that knowledge frequently. As one example, she was captivated by news of the August 2017 neutron star collision discovered by the LIGO and VIRGO Observatories and promptly created a presentation on the subject and shared it at public nights and in club meetings.

Dena's focus as club president has been on making major improvements within the club, on supporting a new national group of young astronomers, Cosmic Generation, and on building the volunteer cadre. She hopes to spend more time observing, hiking, traveling, visiting friends and family, and socializing. Dena loves animals and advocates for the environment and social justice issues.

BRUCE BOOKOUT, MARS REPRESENTATIVE

Bruce Bookout has been an amateur astronomer since childhood and earned his BS degree in physics from the University of South Florida. During his senior year, he worked with the Museum of Science and Industry to establish the Museum Astronomical Resource Society (also MARS), serving as president.

He obtained his MS degree in space systems operations management from Webster University and joined the U.S. Air Force in 1990. He worked on various USAF space operations systems including the Space Surveillance Network, the Global Positioning System, the Defense Support Program, and the Peacekeeper Intercontinental Ballistic Missile Program. While stationed on Diego Garcia, he and Navy personnel established the Diego Garcia Astronomical Society, and he also served as its president.

Returning stateside to Colorado Springs, he became involved with the Colorado Springs Astronomical Society, serving as vice president, ALCor, trustee, director for the Rocky Mountain Star Stare, and outreach deputy. He holds the League's Master Outreach certification and teaches astronomy as an adjunct professor at Pikes Peak State College (PPSC). His courses include planetary and stellar astronomy and a course in archaeoastronomy that he developed. Bruce loves deep-sky observing, uses 12- and 22-inch telescopes, and is a League Master Observer.

Bruce is currently production engineering program manager of the Acusil production facility for Peraton Inc. He is responsible for the manufacture and production of thermal protection materials for programs like the Patriot, Evolved SeaSparrow, and SM-3 missiles, the last two Mars rover missions, and an upcoming Mars sample return mission.

ALAN SHEIDLER, NCRAL CHAIR

Al grew up on a small Ohio farm and began observing with 7×35 binoculars. His father bought him an inexpensive 3-inch reflector. Growing up on a farm and doing astronomy stoked his interest in science and led him to become a mechanical engineer and land a job at John Deere designing combine harvesters. He earned an MSME degree from Bradley University in 1998 and a BSME from Ohio University (Athens) in 1978. He is also a licensed professional engineer in the state of Illinois.

Al has been an active member of the Popular Astronomy Club (PAC) in the Quad Cities for 30 years and has served as club vice president and president. He currently serves as director of observing. Al is very involved in public outreach activities and in 2022 received the Master Level Astronomical League Outreach Award. He has completed many League observing programs including Double Stars, Globular Clusters, Planetary Nebulae, Venus and Mercury transits, and all four

of the NCRAL Seasonal Messier Observing Awards. During the pandemic, Al perfected the use of a DSLR to provide video and still-frame images of celestial objects during public observing events using PAC's mobile observatory (PACMO).

Al retired from John Deere Harvester Product Development in 2016 with 38 years of service but has been called back to consult on the development of cooling systems for combine harvesters. This past spring, he taught a class at Scott Community College called "Engineering Academy" for high school seniors who plan to become engineers or technicians.

DELAWARE ASTRONOMICAL SOCIETY BOOK CLUB

Do you enjoy delving into the field of astronomy or taking outings into the unknown through science fiction? You are cordially invited to join the Delaware Astronomical Society (DAS) Book Club.

Meetings are on the last Thursday of each month at 7 p.m. Eastern time via Zoom. We usually have a speaker, either a subject matter expert or someone with a connection to the book, the author, or a family member.

The DAS Book Club Calendar is regularly updated and online at *www.delastro.org/members/das-book-club.*

UPCOMING DAS BOOK CLUB READS

September 28, 2023 – *Adventures of an Eclipse Chaser* by Roderick J. Hill

"Over thousands of years, every corner of the Earth's surface gets to host an eclipse, but they only pass over any particular place every 375 years or so. So if you want to see a total eclipse, you usually have to 'chase' them." The author will join us for discussion.

October 26, 2023 – *Eye of the Beholder* by Laura J. Snyder

October's read commemorates the tercentenary of the death of Antony van Leeuwenhoek (1632–1723) and the landmark 2023 exhibition of Jan Vermeer's work at the Rijksmuseum. The author will join us for our discussion.

November 30, 2023 – *The Book Nobody Read: Chasing the Revolutions of Nicolaus Copernicus* by Owen Gingerich

The November selection marks the 550th anniversary of the birth of Copernicus and the recent death of the renowned Copernicus scholar, historian of science, and author, Dr. Owen Gingerich. Sarah Horowitz, curator of rare books and manuscripts at Haverford College Libraries, will join us to discuss the Haverford College copy of *De Revolutionibus.* Christian Westergaard, the director of Sophia Rare Books, will also join us to discuss the bookstore's rare first edition of *De Revolutionibus.*

To receive DAS Book Club announcements, please email Mary Webb at *dasbookclub@gmail.com.*

NEW OBSERVING CHALLENGES FOR UPCOMING ECLIPSES

The Astronomical League has two new Observing Challenges related to the upcoming annular and total solar eclipses across the United States. These two items have been added to the observing portion of the AL website. Please plan on enjoying these eclipses safely, and if you would like to earn a certificate and pin, consider doing the projects that are described there. If you have any questions, contact Brad Young via his website, *hafsnt.com.*

League Awards

BY CHUCK ALLEN

Here are the winners of all 2023 League youth and general awards.

NATIONAL YOUNG ASTRONOMER AWARD

Now in its 31st year, NYAA is supported by the generosity of Scott Roberts and Explore Scientific, which provides outstanding astronomical instruments to our top two winners. Our judges are professional astronomers and engineers and a former Intel International Science and Engineering Fair lead judge. This year, for the first time, we had a tie for first place. Both of our winners will receive the full first-place telescope prize.

NYAA First Place (tie): Kaitlyn Wang

Kaitlyn Wang is a senior (award-year junior) at The Harker School in San Jose, California. Her project is "Discovery of the Smallest Ultra-Short-Period Planet Using GPFC: A Novel GPU-Parallelized Phase Folding Detection System." She discovered three new ultra-short-period exoplanets from the Kepler survey that all are sub-Earth-sized. Among these, Kepler-1598d is the smallest ultra-short-period planet ever detected from the NASA Archive, and Kepler-270d is a rare ultra-short-period planet orbiting a high temperature F-type star (the 11th of its kind).

Kaitlyn qualified to be a finalist at the 2023 International Science and Engineering Fair, is enrolled in multiple college courses, and is an active amateur astronomer who has hosted city star parties, conducted school-wide eclipse parties, and provided programs in telescope optics and cosmology.

In addition to the telescope, Kaitlyn received a plaque and an all-expenses-paid trip to ALCon 2023 to present her paper.

NYAA First Place (tie): León García

León García is a recent graduate of Corvallis High School in Corvallis, Oregon, and is a former two-time finalist in the NYAA competition (third place last year). He is now attending Stanford University.

León's project is "Simulating the Dynamics, Collisions, and Morphology of Galactic Ultralight Dark Matter Halos." His project simulated the behavior of dark matter halos in collisional galaxies and interstellar gas clouds and during accretion events to improve understanding of their dynamics and role in shaping the distribution of baryonic matter over galactic and intergalactic space. He used pyUltralight, a pseudo-spectral solver that can model ultralight dark matter halo behavior. To calibrate the models, he revisited prior simulations of colliding galaxies established in other literature and simulated the accretion of dark matter halos around a central mass.

His present and past research qualified him as a finalist at the 2021, 2022, and 2023 Regeneron International Science and Engineering Fairs.

In addition to the telescope, León received a plaque and an expenses-paid trip to ALCon 2023 to present his paper.

NYAA Third Place (tie): Lucas Libshutz

Lucas Libshutz is currently a senior (award-year junior) at the Columbia Grammar and Preparatory School in New York City.

Lucas's project is "Creating Superresolution Spectra from Titan's Equatorial Dunes." His research devised a way to leverage a systematic error in the Cassini mission's Visual and Infrared Mapping Spectrometer study of Titan's surface and atmosphere to create a superresolution spectrum of the surface.

Lucas received a plaque for his top-three finish.

NYAA Third Place (tie): Mohd Tarunno

Mohd Tarunno is currently a sophomore (award-year freshman) at Upper Darby High School in Upper Darby, Pennsylvania.

Mohd's project is "Identifying Lunar Lava Tubes Using Thermal Inertia Mapping." His project determined that undiscovered lunar lava tubes can be located using thermal inertia mapping.

By mapping temperature data from the Diviner instrument on the Lunar Reconnaissance Orbiter, sorting them into daytime and nighttime temperature maps, and then subtracting the nighttime from the daytime maps, the resulting thermal inertia maps successfully displayed known lava tubes.

Mohd received a plaque for his top-three finish.

HORKHEIMER/SMITH AWARDS

The League offers two major youth service awards, the Horkheimer/Smith Award and the Horkheimer/D'Auria Award, both with cash prizes.

HORKHEIMER/SMITH SERVICE AWARD

Winner: Christina Ding

Christina Ding, a member of the Texas Astronomical Society of Dallas (TASD), is this year's Horkheimer/Smith Award winner.

From 2018 to 2021, Christina provided weekly lessons in astronomy, math, and English to elementary school students from low-income areas in China. Employing PowerPoint presentations for the astronomy lessons, her courses rapidly grew in popularity.

Christina is an International Astronomy and Astrophysics Competition (IAAC) Ambassador. She encourages others to participate in the IAAC, including her high school physics team, which she leads as president. She is a recipient of the IAAC President's Service Bronze Award.

Christina is secretary of the TASD's Teen Section, communicating with teen members about club activities and reporting the activities of Teen TAS to the newsletter editor. She surveys members to determine their interests and actively participates in TASD events such as Moon Day. In 2022, she participated in the NASA Astrophoto Challenges, which involved remote control of MicroObservatory telescopes to obtain images of the Eta Carinae Nebula. Her image was selected as a standout image from among 1,500 submissions.

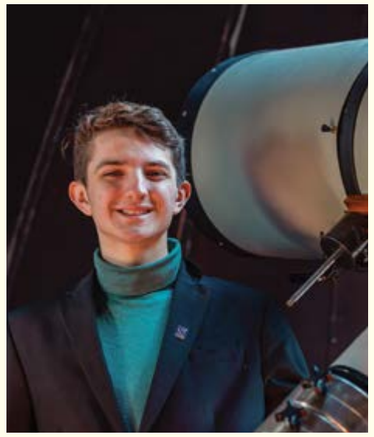
Christina received a plaque, a $1,750 cash prize, and was offered an all-expenses-paid trip to ALCon 2023.

HORKHEIMER/D'AURIA AWARD

Winner: William Gottemoller

William Gottemoller, a recent graduate of Menomonee Falls High School (MFHS) in Milwaukee, Wisconsin, and member of the Milwaukee Astronomical Society (MAS), is this year's Horkheimer/D'Auria Service Award winner. He is now a freshman at Harvard with an intended major of astrophysics.

Coupled with his Smith and Parker wins last year, William is the first person to win three major youth awards. He founded his high school's astronomy club, became the MAS's youngest keyholder and board member, and has taken award-winning images using club telescopes. He has been instrumental in making observatory improvements including gaining board approval for an Astro-Physics mount and spearheading efforts to install Wi-Fi.



He established a leadership team to ensure the continued success of the MFHS astronomy club. He partnered with Geneva Lake Astrophysics and STEAM to operate a 20-inch telescope in Sonoma, California, and with the Nicolet High School Astronomy Club to run joint meetings and star parties. Under his leadership, the MFHS astronomy club became one of the school's largest clubs and featured annual field trips to the MAS and Yerkes Observatories. William has taught members how to use the MAS's computerized telescopes and has mentored youths in astrophotography. He has been featured in *Amateur Astrophotography* magazine and has appeared on local television.

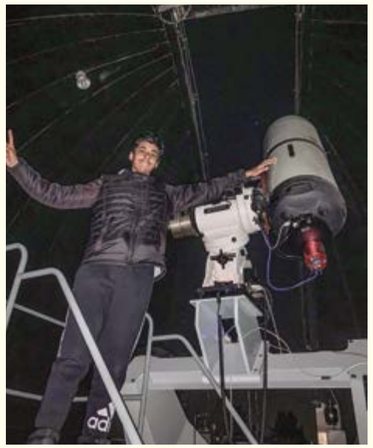
William received a plaque and a $1,000 cash prize.

HORKHEIMER/PARKER IMAGING AWARD

The League hosts a youth imaging competition, the Horkheimer/Parker Imaging Award, with cash prizes.

Winner: Dhruva Kalyani

A member of the Milwaukee Astronomical Society, Dhruva Kalyani is this year's winner of the Horkheimer/Parker Youth Imaging Award. His



winning image is of the Jellyfish Nebula. Dhruva is a senior (award-year junior) at New Berlin High School and has been working under the skilled mentorship of last year's Smith and Parker Award winner, William Gottemoller. He received a plaque and a cash prize of $1,000.

Runner-Up: William Gottemoller

William Gottemoller (photo on previous page), a member of the Milwaukee Astronomical Society, is this year's runner-up for the Horkheimer/Parker Youth Imaging Award. His image is of the Crescent Nebula. William is a past winner of the Parker Award and mentored this year's winner, Dhruva Kalyani, in his winning effort. William received a plaque and a cash prize of $500.

HORKHEIMER/O'MEARA JOURNALISM AWARD

The League conducts an annual science writing competition for youths age 8 to 14. The top two winners of the Horkheimer/O'Meara Journalism Award received beautiful plaques and cash prizes.

Winner: Avni Dhargalkar

Avni Dhargalkar, age 12, was adjudged the winner of the Horkheimer/O'Meara Journalism Award. Avni is currently an 8th grader (award-year 7th grader) at the Charles F. Patton Middle School in Kennett Square, Pennsylvania, and

a member of the Chester County Astronomical Society.

Avni received a plaque and a $1,000 cash prize for the winning essay, "The First Space Tourist." Here is her essay:

THE FIRST SPACE TOURIST

"Talgat Musabayev, how does it feel to be involved with such an important part of history, commanding the mission of the world's first space tourist? What does it mean for the future?"

Many versions of these words have been asked of me by obscure reporters and friends. And sometimes I reflect on these questions. You, my friends, will now hear the story, and, if you read closely, you may find the answers.

I was 50 years old when I first heard the name Dennis Tito. He had paid quite a large amount of rubles (20 million American dollars) to board a Soyuz rocket to one of our satellites. It was called Mir; however, it was deorbited before he could board it. I'd heard that he was still determined to head to space, and that's when I was told he was going on a mission with us to the International Space Station. I was to be the commander of the mission. I must admit, I was a bit skeptical. What repercussions could sending an untrained American to space have? I supposed I would find out... NASA had informed us that they didn't recommend following through with this plan, as they were nervous about Tito having the right amount of training. However, we knew they were trying to save themselves in case something went wrong. On April 28, 2001, Dennis Tito, our flight engineer, Yury Baturin, and I boarded a Soyuz spacecraft to the International Space Station.

Although I'd had my doubts about Tito, he quickly set to helping out on the ISS. His only official jobs were enjoying the tremendous view of Earth and taking pictures, however, he also helped pick out which food would be eaten during the meals. He was not in the way at all, he fit in perfectly, and he helped when he was not required to do so. We took to calling him "Titov," the name of our country's second man in space. We returned home on May 1, 2001.

So, the world's first space tourist was not a tourist, but an active member of our community on the ISS. My last mission in space was flying with him, and I'm glad I got the chance to do so. I became the head of KazCosmos six years later, but I still fondly remember this experience. Titov looked back on this as one of the best things that ever happened to him. Despite NASA's initial negative opinions, he still has a positive outlook on the American space agency. I, along with some of the world, believe that if Titov hadn't gone up to space with us on that fateful day, many other people may not have seen the potential of space tourism. The future is bright, bold, and a little easier to embrace, because of Dennis Tito. And this marks the end of my tale and the beginning of our future.

Runner-Up: Thérèse Bauer

Thérèse Bauer of Oronoco, Minnesota, submitted the runner-up essay in this year's contest. Thérèse is currently a homeschooled 8th grader (award-year 7th grader) and a member of the Rochester Astronomical Society.

Thérèse's essay was "Cookies and Cooperation on the International Space Station." Her essay examines the ISS's zero-gravity oven and uses her own love of baking cookies as a metaphor for the high level of international cooperation aboard the ISS.

Thérèse received a plaque and a cash prize of $500.

MABEL STERNS NEWSLETTER AWARD

This award recognizes club newsletter editors whose job is to communicate with members. The award was judged by a panel that included three present or past League club newsletter editors.

First Place: Richard Bell

Richard Bell is president, webmaster, and newsletter editor of the Kalamazoo Astronomical Society. Richard has served as newsletter editor

of the KAS's *Prime Focus* newsletter for 27 years, producing well over 300 issues.

Prime Focus creates a visually stunning and colorful online presence for the KAS. The newsletter is extraordinarily easy to navigate, is meticulously current, and features a wide range of science articles, member articles, charts, event listings, ads, and member photo galleries.

Richard is the longest serving president in KAS history, has been involved in substantial fund-

raising for the club over the years, hosts online viewing sessions featuring a remote telescope in Arizona, and conducts a five-part Introduction to Amateur Astronomy lecture series. He received a large plaque for his work.

Runner-Up: Mike Jensen

Mike Jensen is a member of the Southwest Florida Astronomical Society and serves as editor of the club's newsletter, *The Eyepiece.* The newsletter is typically over 20 pages long and is informative and beautifully illustrated.

Mike received a framed certificate for his excellent submission.

Third Place: Lisa Weiland

Lisa Weiland is a member of the Wabash Valley Astronomical Society and serves as editor of the society's newsletter, *The Nebula.* Lisa's newsletter is also typically over 20 pages and filled with well-illustrated and current information.

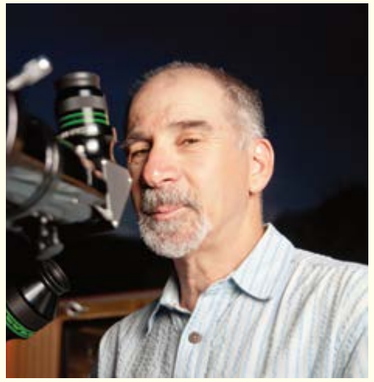
Lisa received a framed certificate for her superior work.

WEBMASTER AWARD

This award recognizes club webmasters whose job is to communicate with the public and potential members. The award was judged by a panel of webmasters and a League officer.

First Place: Bernard Arghiere

Bernard Arghiere serves as webmaster of the Astronomy Club of Asheville in North Carolina. He is a past president of the club and has served as



its webmaster for many years.

Bernie's website is a visually stunning and colorful on-line presence for the ACA. The site offers smooth navigation, is current, features a wide range of menu selections, and boasts a substantial gallery.

Bernie received a large plaque honoring his award-winning work.

WILLIAMINA FLEMING IMAGING AWARDS

In 2021, the League introduced an imaging award named in honor of Williamina Fleming (1857–1911). Award plaques for this program are generously provided by Scott Roberts of Explore Scientific.

The award recognizes superb imaging skills among female members of the Astronomical League and is judged by a panel of widely published and award-winning imagers.

This program accepts entries in four categories: deep sky (>500 mm focal length, no Solar System); Solar System (>500 mm), wide field (201–500 mm), and wide field (200 mm or less).

DEEP SKY (>500 mm)

Winner: Ann Chavtur

Runner-Up: Suzanne Beers

Ann Chavtur and Suzanne Beers are both members of the Colorado Springs Astronomical Society, and they earned the top two spots in the deep sky competition.

Ann's winning images were of the Bubble Nebula (NGC 7635), Thor's Helmet (NGC 2359, shown on p.16), and the Tadpole Nebula (NGC 1893). These photos were taken from her home in Monument, Colorado, using a Nikon 750 DSLR and a 6-inch f/9 iOptron Photron Ritchey-Chrétien telescope.

Suzanne's runner-up images included the Horsehead Nebula and Flame Nebula, the West Veil Nebula (NGC 6960), and the Great Nebula in Orion (M42). Her photos were taken from Colorado Springs (NGC 6960) and from the Kiowa National Grassland

in New Mexico (Horsehead and M42) using a Canon EOS Ra and an 8-inch f/8 Orion Ritchey-Chrétien telescope.

Ann and Suzanne received plaques representing their imaging achievements.

SOLAR SYSTEM (>500 mm)

WIDE FIELD (≤200 mm)

Dual Winner: Terry Mann

Terry Mann, a past president and current secretary of the League, won both the Solar System and wide field categories.

Her winning Solar System image is an H-alpha

image of the Sun entitled "Solar Mystic Mix." She took the image from her backyard in West Manchester, Ohio, using a Canon 5D Mark III camera and a 90 mm f/8.8 double-stack SolarMax. Her winning wide field image, "A Night with the Moai," is a spectacular southern sky photo taken as a composite with Ahu Tongariki moai in the foreground. She took the image on Easter Island using a Canon 6D and Sigma Art 20 mm lens at f/2.

Two plaques were presented to Terry in recognition of her wins in these categories.

SKETCHING AWARD

The purpose of the Sketching Award is to recognize the art of astronomical sketching at the eyepiece. This award is sponsored by the generosity of Telescope Trader *(telescopetrader.com)*.

Winner: Jon Schwartz

Jon is a League member-at-large who lives in Simi Valley, California. He observes using a 32-inch f/3 reflector and a 28-inch f/4.3 SlipStream telescope. His winning sketch is a detailed white-

on-black rendition of the Whirlpool Galaxy, M51. The sketch, made at 299×, was done with pencil on printer paper blended with stubs. The sketch was then uploaded to Procreate, inverted, and painted with airbrushes and a luminance brush. Jon received a large plaque and a cash prize of $250.

Runner-Up: Raymond Whatley

Raymond is a member of the Northeast Florida Astronomical Society and lives in Orange Park, Florida. He observes using a 10-inch Newtonian reflector. His sketch is a color rendition of the Eta Carinae Nebula made at 90×. Made with graphite pencils and blending stumps, the sketch was then scanned, inverted, and colorized to show the teal color of the nebula and the distinct red of embedded star Eta Carinae.

Raymond received a plaque and a check for $150.

PELTIER AWARD

The Peltier Award was created in 1980 and the first was awarded in 1981. The award is named after Leslie C. Peltier, the Delphos, Ohio, amateur astronomer who Harlow Shapley, one of the League's founders, referred to as "the world's greatest nonprofessional astronomer."

2023 Peltier Award Recipient

Julius L. Benton Jr.

It is with great pleasure that we announce Julius L. Benton Jr. as the recipient of the 2023 Leslie C. Peltier Award.

Julius L. Benton Jr. has been an amateur astronomer nearly all of his life, with extensive observational experience at many levels and practices in the realm of Solar System astronomy. Julius's interest in amateur astronomy began in childhood with the encouragement of his parents, Julius Sr. and Susan, as well as his Aunt Mary Ann Jones. It all began for Julius at the age of ten with a Christmas gift of a small telescope, a 2.4-inch Unitron refractor. Julius extensively explored the heavens with that telescope, graduated to progressively larger telescopes, and became fascinated with the always changing planets and the transient features they portrayed. It wasn't long before young Julius began documenting his observations by recording careful drawings and observational notes in logbooks for future reference.

Disappointing job prospects in professional astronomy channeled Julius's academic talents toward an undergraduate degree in physics and environmental sciences, but his interest in Solar System astronomy only increased with time. Julius attended his first amateur astronomical convention in 1970 where he met his future mentor, Walter H. Haas, founder and then director of the Association of Lunar and Planetary Observers. The informal collegiality and diversity of the experienced observers in ALPO inspired Julius to get involved in the organization as a paid member and observer. As his graduate studies concluded, Julius was asked to apply his skills and expertise as a knowledgeable amateur by managing ALPO observing sections. He was first appointed by Walter Haas to lead the ALPO Saturn Section as its recorder (recorders are now called coordinators) in May 1971. Julius became recorder of the Venus Section in 1973.

Julius has been prolific in his apparition reports concerning Saturn and Venus in the *Journal of the ALPO* during the past 50+ years, and he has produced a variety of materials freely available on the ALPO website. In later years, Julius also assumed responsibilities for managing the ALPO Lunar Selected Areas Program as well. Julius's great interest and love for Solar System astronomy and ALPO has also translated into added responsibilities, serving on the ALPO board of directors since 1994 and supporting the organization as its executive director at various times since then.

While Julius is an outstandingly skilled observer and a recipient of the Walter H. Haas Observers' Award in 2018, Julius credits the success of the observing sections and programs to the legions of observers that have contributed observations to the ALPO over many years. Many observers have been inspired and benefited from Julius's encouragement, insights, expertise, and diligent interest their efforts. In turn, Julius has been a champion for amateur observation of the Solar System for scientific pursuit and has promoted a shared, long-time interest in these observers and their observations with the professional community. Julius's accumulated knowledge and experiences with the planet Saturn culminated in the publication of a popular guide to the planet, *Saturn and How to Observe It,* published by Springer.

Through his many contributing services to the ALPO and the broader astronomical community and his hard work in observing the Solar System and leading others to do the same, Julius Benton has broadened the popularity and increased the knowledge of lunar and planetary astronomy for many.

Respectfully submitted,
The Leslie C. Peltier Award Committee
Roger S. Kolman, PhD, Chair
Barry Beaman
Russ Maxwell

MORE ▸

Ann Chavtur's Williamina Fleming Imaging Award winning image of Thor's Helmet (NGC 2359) *©Ann Chavtur, 2023*

ASTRONOMY SUPER BLOOM

By Jerelyn and Paul Ramirez

In April 2023, Paul and I traveled to the southwestern corner of Kansas to the town of Ulysses, population 3,790, in Grant County. I was invited to the Sullivan Elementary School to put on a presentation for the school's six third grade classes. My contact, Anna Mejia, sent me a copy of her unit overview on the astronomy and science lessons she was required to teach the kids for this semester. What was fun about the overview is I had outreach activities for nearly all the astronomy science lessons listed. As Anna and I were negotiating what presentations I would have available for the kids, she proposed adding the 4th and 5th grade classes for a total of 316 kids. By then I was all in.

The sleepy town of Ulysses is situated in a semiarid high plains area of Kansas without access to the science culture in the Wichita area. I was attracted to this town because it is an astronomy desert. In a desert, when you have much needed rain (it did rain for two days as we were driving out there), you have a "super bloom" soon after the rain. This is why I call my story an astronomy super bloom, paying it forward to a small town and giving the kids access to astronomy they normally would not have.

We set up in their gymnasium and the kids were split into five sessions over two days. The kids were excited when we asked to sit at their table to chat with them during their lunch break. Paul couldn't get his knees under the kids' table so he sat at the adult table. A few kids moved to the adult table with him to keep him company – it was so cute. They thought he looked lonely.

We explored our Solar System with a scale model, with the Sun a meter in diameter and Earth 9 mm in diameter. The kids could relate to the size of a soccer field (because most of them play soccer) as the distance the 9 mm Earth would be from the 1 m Sun. We included Pluto in the model, and it would be 2.6 miles from the 1 m Sun, which is about the width of the town of Ulysses. We had a lot of fun with this model as we talked about Jupiter and its orbital period of nearly 12 years. Because all the kids were less than 12 years old, I explained that Jupiter hasn't made one trip around the Sun in their lifetime. When I told them Jupiter has made 5 trips around the Sun in my lifetime, I asked how old I was. They were quick to answer "60." So, I then told them if I lived on Jupiter, I would be 5 years old. Their minds were blown. I was able to demonstrate that ten Jupiters in a row are equivalent to the diameter of the Sun, and eleven Earths would be the same diameter as Jupiter; the kids were quick to understand it would take 110 Earths to span the diameter of the Sun.

photo by Paul Ramirez

We followed up making pocket Solar Systems using cash register tape. They learned Uranus is at the halfway point out to Pluto's farthest point (20 vs. 40 astronomical units).

We then talked about the Apollo missions and how we are planning to return to the Moon with the Artemis missions. They were excited they could grow up and possibly be a part of future Moon and Mars missions.

We finished out the presentations by talking about gravity using weights and marbles to show how mass curves space. After doing a few demonstrations, I let the kids experiment with the gravity buckets on their own. We even used straws to experiment with "escape velocity" by blowing on a small marble next to a planet of greater mass. The greater the mass, the harder it was to achieve escape velocity by blowing through the straw.

After the sessions, I was met with fist bumps from the students, and one gave me a hug. We reached out to 166 kids on the first day and 145 kids the second day, for a total of 311. It was so much fun to give these presentations to the children of the Sullivan Elementary School in Ulysses. I have to admit, by the end of the last session I was tired, but it was a good tired. I loved it. Paul and I camped for three nights in a nearby RV park in our new RV for $15 a night.

I emailed Anna Mejia several handouts ahead of time and I brought some leftover handouts from previous outreach presentations, many in Spanish. I was really surprised when all of it was taken, especially the Spanish material. About 70 percent of the student body were Mexican and a few had not mastered the English language yet. What was fun is how engaging they were while using their classmates to interpret for them. They were all inquisitive, attentive, enthusiastic, and engaged.

Students were particularly interested in learning the cause and effect of gravity using the gravity buckets – the more weight is applied, the more space curves. With this curved space they saw how the planets (marbles) would orbit the more massive center "star." The different weights represented a white dwarf, a star like our Sun, and a blue supergiant star. Lead weights were multi dipped and coated with Plasti Dip in three colors representing the three stars, to protect the kids from lead exposure while experimenting with this hands-on activity. They were also blown away by two objects of different masses being dropped and hitting the Earth at the same time. This was proved using the gravity bucket and just by dropping them onto the floor. Most guessed the smaller object would hit the floor first, some guessed the larger of the two; hardly any said both would hit at the same time. It was interesting to hear their predictions before I released the objects. They also saw how an orbiting body would indeed make the 'star' wobble, which led to a discussion of discovering exoplanets.

I would definitely visit this school again, if invited. Interestingly, the question most frequently asked by all the students was, "Have you ever been to outer space?" ✶

THE DEER LICK GALAXY GROUP AND DEERLICK GAP OVERLOOK

Debbie Ivester holding Nova Sophia, and Roger Ivester. Photo courtesy of the author.

By Roger Ivester

While driving through Little Switzerland, North Carolina, we stopped at Deerlick Gap Overlook, just off the Blue Ridge Parkway. I've always considered this to be a famous location for amateur and professional astronomers alike.

The overlook became the namesake for the faint galaxies NGC 7335, 7336, and 7340 in Pegasus, which has become known as the Deer Lick Group. The name had nothing to do with the appearance of the galaxies, but from the location from which they were observed.

Tom Lorenzin, author of *1000+: The Amateur Astronomer's Field Guide to Deep-Sky Observing,* was observing from the Deerlick Gap Overlook one incredibly transparent night in October 1983. He was able to get an extraordinary view of the faint triangle of galaxies. The name stuck, and the galaxies are now known to many as the Deer Lick Group.

Tom Lorenzin passed away from a heart attack on August 23, 2014, in Winston-Salem, at the age of 67. I had known Tom for many years, receiving advice on both visual observing targets and pencil sketching. Unfortunately, I've never been able to see the Deer Lick Group from my 4.8–5.0 naked-eye limiting magnitude suburban backyard using my 10-inch f/4.5 equatorial Newtonian. However, it's my goal this year to attempt this trio of galaxies from a dark site, and if I'm successful, a thirty-year goal will be achieved.

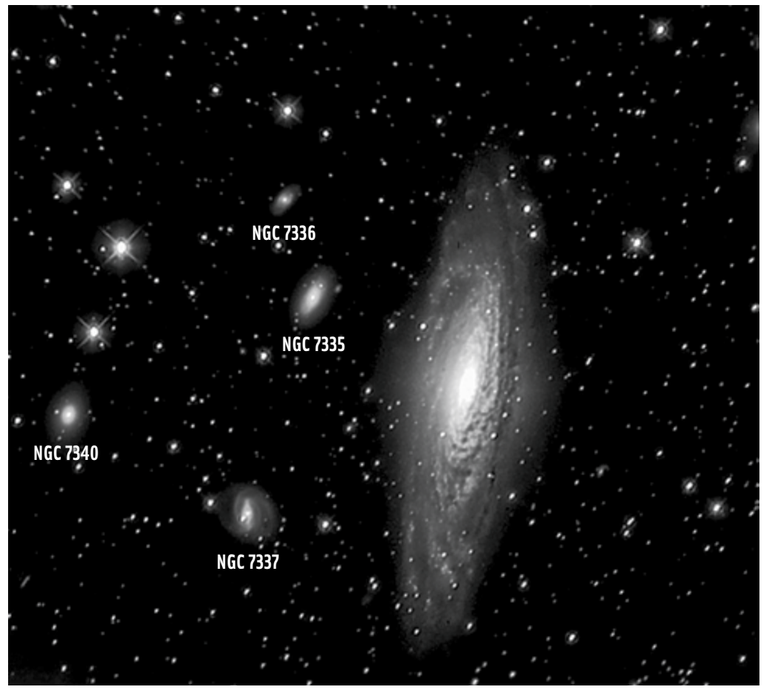
The following are Tom Lorenzin's descriptive notes from *1000+* based on his October 1983 observing session.

NGC 7331: 10.4M; 10' x 2.5' extent; bright and much elongated edge-on spiral with stellar nucleus; axis oriented NNW-SSE; the Deer Lick group, a very faint triangle of 14+M GALs (N7335,6,40) is a few minutes E and a little N; "STEPHAN'S QUINTET" (soft glow of five very faint and distant GAL's) is 30' due S; good supernova prospect.

In the image below, taken by Mario Motta with his 32-inch telescope, the Deer Lick group appears to the left of NGC 7331. A serious visual observer can spend many nights in this area, and hopefully will be able to see all of the listed galaxies.

Good luck! ✶

Roger Ivester is a member of the Las Vegas Astronomical Society and Amateur Telescope Makers of Boston



DWARF NOVAE

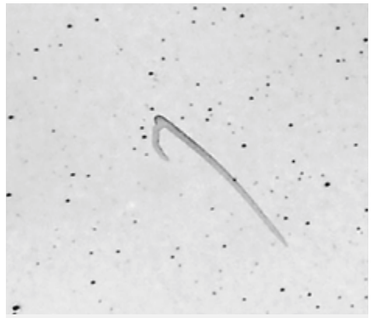
By Al Lamperti and Frank Colosimo

If dwarf novae could have collective voices, they would mimic Rodney Dangerfield: "We don't get no respect!" Overshadowed in headlines by their cousins, novae, and by their great granddaddies, supernovae, who are always in Hollywood spotlights, dwarf novae quietly perform in the universe without much applause or attention.

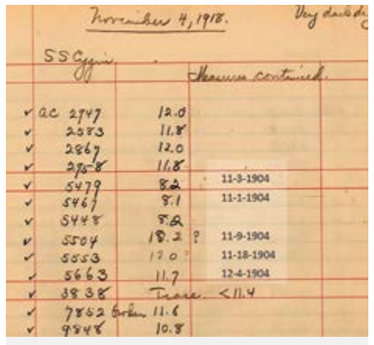
We were unfamiliar with dwarf novae until one of us started the Astronomical League's Nova Observing Program *(www.astroleague.org/content/nova-observing-program)*. In the description of that program, the author notes that dwarf novae are types of cataclysmic variable stars, with a much lower luminosity than regular novae and which recur over a period of days to years. A white dwarf primary star pulls material from a red dwarf secondary star, forming an accretion disk, which periodically has explosions, producing recurrent increases in brightness. For many years these objects were noted and observed to be variable stars. Several investigators in the early 1970s described the mechanisms that contribute to their variability. A nice discussion with color diagrams of these variables can be found at *imagine.gsfc.nasa.gov/science/objects/cataclysmic_variables.html.*

HISTORICAL PERSPECTIVE

The first variable star to be later categorized as a dwarf nova was U Geminorum, discovered in 1855. It had periodic outbursts approximately every 100 days. In 1896, Miss Louisa D. Wells, a computer hired by E. C. Pickering at the Harvard College Observatory, noted a different star on photographic plates taken with the 8-inch Draper doublet at Cambridge to have a period of about 40 days and a brightness range from magnitude 7.2 to fainter than 11.2. The logbooks first recorded the object as "Var. L.D.W." A year later it was named officially SS Cygni in the *Astronomical Journal.*



Inked arrow from Harvard Plate I 16021 indicating a variable star found by Louisa D. Wells in 1896. North is to the right.



Screen capture from Project PHaEDRA showing the notebook from computer Ida Woods depicting the plate numbers and magnitudes of SS Cygni from the Harvard Observatory plate collection. The dates of the selected plates (lighter rectangle) were found on the DASCH website and added by this author. Note the magnitude changes in just one month.

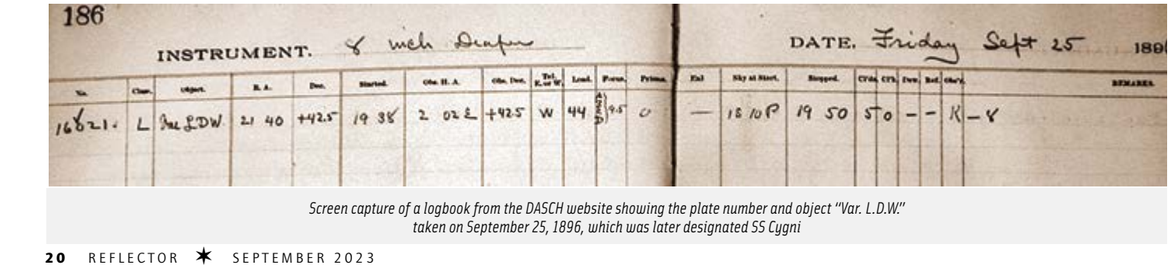
The magnitudes of SS Cygni were documented in the notebooks of other Harvard computers, Ida Woods and Sarah Breslin. Thousands of observations of variable stars can be found in the digitized plates and logbooks in "DASCH: Digital Access to Sky Century @ Harvard" *(dasch.rc.fas.harvard.edu/telescopes.php)* and the notebooks found on the Zooniverse project "Star Notes." The latter is part of PHaEDRA (Preserving Harvard's Early Data and Research in Astronomy), which, in conjunction with the Smithsonian Transcription Center, strives to connect the notebooks with the plates in the Harvard collection. Both are a trove of data waiting to be mined.

TYPES OF DWARF NOVAE

Dwarf novae can be divided into four classes, depending upon their light curve. Stars in the first class, the **SS Cyg** type (for example, U Geminorum), have periodic outbursts. **Z Cam** types have standstills in their light curves lasting days to years. **SU UMa** types have very narrow outbursts with occasional super outbursts. Short brightness variations during each super outburst seem to coincide with the orbital period. **WZ Sge** types have very infrequent outbursts.

ESTIMATING MAGNITUDES

Dwarf novae can be observed or imaged and their magnitudes recorded at any time of the year, as they can be found in constellations in all four seasons, for example, SS Cygni and U Scorpii in summer; RX Andromedae in fall; U Geminorum in winter; and SU Ursae Majoris in spring. The American Association of Variable Star Observers (AAVSO) collects magnitude estimates of dwarf novae sent in by observers and imagers. The compiled data help scientists understand the processes occurring in these stars.



Screen capture of a logbook from the DASCH website showing the plate number and object "Var. L.D.W." taken on September 25, 1896, which was later designated SS Cygni

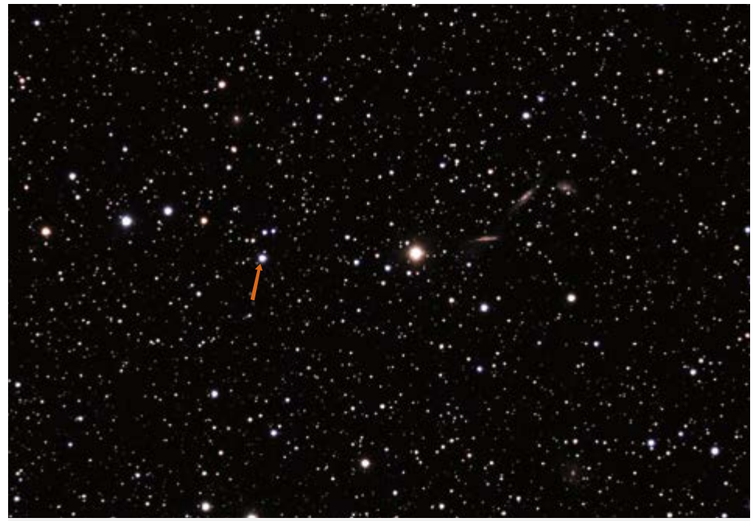
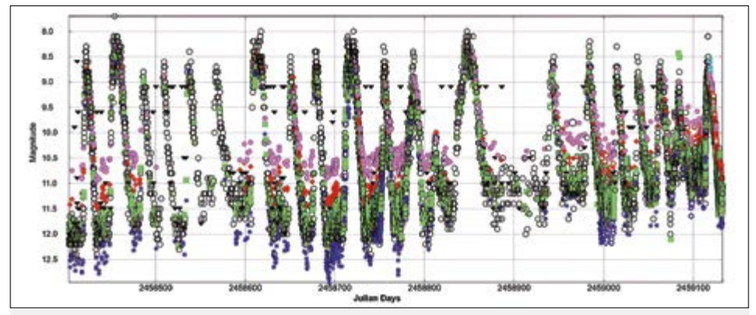
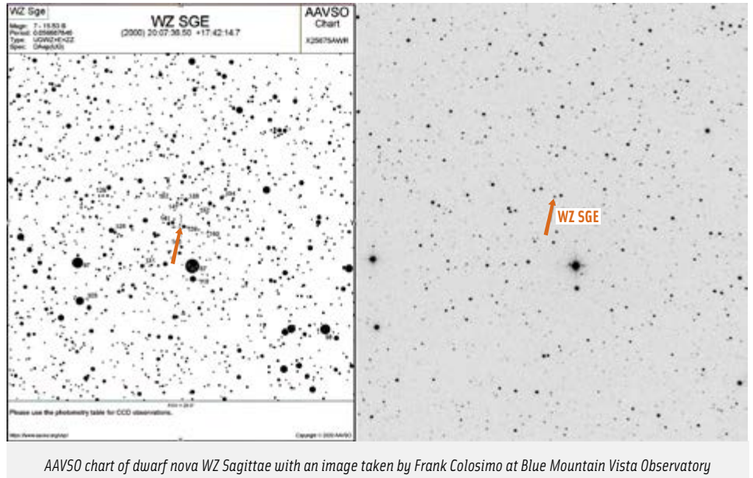


Image of SS Cygni taken by Frank Colosimo at Blue Mountain Vista Observatory



The light curve of SS Cygni generated from visual and imaging submissions to the AAVSO from October 2018 to September 2020.



AAVSO chart of dwarf nova WZ Sagittae with an image taken by Frank Colosimo at Blue Mountain Vista Observatory

The recent SS Cygni light curve from the AAVSO website shows this dwarf nova varying between magnitudes 8 and 12 over a relatively short period of just one month. One can also print a location chart from the same website for a dwarf nova or other variable stars. The charts identify stars of known magnitudes so one can compare at the eyepiece the magnitude of the dwarf nova to those comparison stars. Your estimated magnitude along with the date and universal time can be uploaded easily to the AAVSO website along with the reference stars and the chart number being used. Your observation then becomes one of these data points. You can also retrieve all your entries from the AAVSO website.

YOUR ROLE IN THEIR FUTURE — CITIZEN SCIENCE

Since many dwarf novae behave erratically and unpredictably, one's contributions can help unravel some of their mysteries and assist professional astronomers in determining the physical mechanisms behind their phenomena. In doing so, you capture for posterity the dynamism occurring in the universe. You can be rewarded for your efforts by participating in the Citizen Science Observational Program of the Astronomical League: *www.astroleague.org/content/citizen-science-special-program)*

DWARF NOVAE	AAVSO CHART	MIN.	MAX.	PERIOD	CYCLE LENGTH
AR Andromedae	X28809V	17.6	11.0	0.163	23 days
DX Andromedae	X28809W	15.5	11.0	0.440502	330 days
LL Andromedae	X28809X	20	12.6	0.055055	
RX Andromedae	X28809Z	14.8	10.3	0.209893	13 days?
V455 Andromedae	X28809AA	16.5	8.5	0.5630921	Outburst 2007
Z Camelopardalis	X28809AC	14.5	10.0	0.289841	
SS Cygni	X28809AD	12.2	8.3	0.27513	4–10 weeks
U Geminorum	X28809AE	14.9	8.2	0.1769061	Few months
SX Leonis Minoris	X28809AF	17.4	13.0	0.06717	34–64 days
DM Lyrae	X28809AH	18.0	13.6	0.65409	1928 & 1996 outburst
Nova Persei 2018	X28809AI	16.9	6.3		
NSV 1436	X28809AJ	19.2	12.2	0.0706	1948 & 2011 outburst
U Scorpii	X28809AK	19.3	7.5	1.2305522	~10 yr outbursts
WZ Sagittae	X28809AL	15.53	7		2001 outburst
V1017 Sagittarii	X28809AM	15.1	6.4	5.78629	1901,1973,1991 outbursts
SU Ursae Majoris	X28809AN	16.0	10.8	0.0763754	11-17; super outbursts=153–260
SS Ursae Minoris	X28809AO	17.6	12.6	0.06778	

For more information on the AAVSO Cataclysmic Variables Observing Section, visit *aavso.org/cataclysmic-variables.* ✶

Al Lamperti and Frank Colosimo are members of the Delaware Valley Amateur Astronomers in Pennsylvania and stand in respect of all celestial giant and dwarf objects.

EDWIN HUBBLE: THE SURVEYOR OF THE UNIVERSE

By Larry McHenry

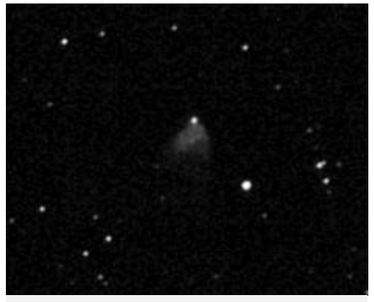
Edwin Hubble (public domain photo)

One hundred years ago, on the night of October 5, 1923, a discovery was made that changed our understanding of the cosmos. American astronomer Edwin Hubble, using the new 100-inch Hooker reflector telescope at Mt. Wilson Observatory, identified within what was then called the Andromeda Nebula the first extragalactic variable star. This was the first step to discovering the expansion of the universe. Some historians consider Hubble's discovery to be one of the greatest in astronomy since Galileo's time.

Through his work of studying variable stars in galaxies, Hubble broke new ground in our understanding the universe, and along the way led to the formation of the Big Bang theory. This article summarizes his early life and how he made this important discovery.

Edwin Hubble was born at his grandparents' farm home in Marshfield, Missouri, on November 20, 1889. As a young boy, Edwin loved to read books, especially the stories of Jules Verne. As a gift for his eighth birthday, Edwin's grandfather built a basic telescope for Edwin, which helped develop his passion for astronomy. Hubble excelled at his school studies, including math and science, and graduated from high school at the age of 16 in 1906. He received a scholarship to the University of Chicago where he studied mathematics, astronomy, and natural sciences. After graduating in 1910 with a degree in mathematics, he spent the next three years as one of the first Rhodes Scholars at Queens College in Oxford, England, where he studied law and graduated in 1913 with a master's degree. Edwin's father passed away in the summer of 1913, so Edwin returned home to care for his mother and younger siblings. After spending several years teaching high school physics, Hubble re-enrolled at the University of Chicago to study for a doctorate in astronomy.

Hubble obtained a scholarship at the Yerkes Observatory of Williams Bay, Wisconsin. As a student at the observatory, Edwin attended a conference of the American Astronomical Society where he met V. M. Slipher from Lowell Observatory who was working on obtaining spectra and radial velocities of spiral nebulae. Slipher's presentation inspired Edwin to devote himself to studying these spiral nebulae. Hubble used the observatory's 24-inch reflector to photograph nebulae and based his PhD thesis, "Photographic Investigations of Faint Nebulae," on this work. Hubble made his first discovery from this project, that the brightness of reflection nebula NGC



NGC 2261 in Monoceros, "Hubble's Variable Nebula" in an image by the author

2261 in Monoceros was variable. This object has since become known as "Hubble's Variable Nebula."

Hubble also studied nebulae located far from the glowing band of the Milky Way. Hubble measured their positions, shapes, sizes, and brightnesses. In several of the regions Hubble studied, small spiral nebulae grouped close together, prompting Hubble to speculate in his paper, "Suppose them to be extra-sidereal and perhaps we see clusters of galaxies; suppose them within our system, their nature becomes a mystery." Hubble was beginning to conclude that spiral nebulae were distant stellar systems at great distances.

During his final year at Yerkes, Hubble met George Hale, the director of Mount Wilson Observatory, who offered Edwin a job once he graduated. However, after graduating from the University of Chicago in 1917, the 28-year-old Hubble enlisted with the U.S. Army to fight in World War I. Hubble quickly rose through the ranks, and within a year, he was promoted to major and placed in charge of a battalion of the 343rd Infantry. But before Hubble could reach the battlefront in France, the war ended. Hubble was discharged from military service in the summer of 1919, and returned to the United States to take the position offered by George Hale.

At Mount Wilson, he was one of the first astronomers to use the new 100-inch Hooker reflector. Hubble was interested in resuming the research he started at Yerkes in determining whether spiral nebulae were just distant, unresolvable gas and stars within our own galaxy, or were external systems to the Milky Way. As part of this work, Hubble also began to develop a classification system for the nebulae he was studying. Hubble became friends with Mount Wilson night assistant and observer Milton Humason, and the two collaborated on a number of projects together. Hubble also developed a rivalry with astronomer Harlow Shapley, who also worked at that time at Mount Wilson studying Cepheid variables to determine whether they could be used as distance indicators within the Milky Way. Both men were interested in solving the mystery of spiral nebulae, with Shapley championing their being internal to the Milky Way (his "big galaxy" as the universe model), while Hubble was in the camp of their being external objects.

In late 1923, Edwin Hubble began dating Grace Burke from Pasadena, who

Hubble's "V1" star in the Andromeda Galaxy, in an image by the author

he had met a few years before during a visitor's tour of Mount Wilson. Grace came from a wealthy, socially connected family, was a Stanford University graduate, and found Hubble's work interesting. In February 1924, the couple married, but never had any children.

On the night of October 5, 1923, Hubble was making a photographic observation of the Andromeda Nebula, using the 100-inch telescope to look for changes. On one 45-minute exposure plate of a region near the core, Hubble discovered a faint star that was brighter than its image on the prior plate. Hubble at first thought the star was a nova, as he had already found several that night within the nebula. But after continuing observations over several nights, and reviewing past plates going back to 1909, Hubble realized that this particular star, which had started to dim, had now begun to re-brighten, meaning it was not a nova. The star was pulsating in brightness, which meant it was a variable star! Hubble relabeled the star as "V1" on the discovery plate. This was the first variable star ever confirmed in a spiral nebula.

Once Hubble was able to plot the star's light curve and identify it as a Cepheid, he was able to calculate its distance, finding that the star was many times further away than what were considered the boundaries of the Milky Way, making both the star and the Andromeda Nebula extragalactic.

Hubble went on to discover other Cepheids within the Andromeda spiral nebula, along with variables in the Triangulum spiral, M33. Using Harlow Shapley's own Cepheid-based distance calculations, Hubble was able to determine all of these other variable star distances, like that of V1, to be much greater than Shapley's own accepted "big galaxy" size of the Milky Way.

Hubble's observations of Cepheids in the Andromeda and Triangulum Nebulae proved conclusively that they were too distant to be located within the Milky Way and that spiral nebulae were, in fact, external to the Milky Way. The first accurate distances to galaxies had finally been determined by Edwin Hubble using Cepheid variables.

Hubble is perhaps more widely known for another important discovery. Working with astronomers Vesto Slipher from Lowell Observatory and Milton Humason at Mount Wilson, Hubble discovered in 1929 that every galaxy outside of our immediate neighborhood has a measurable redshift, suggesting that they are moving away from us. This was the first evidence of galaxies moving away from all other galaxies, indicating the overall expansion of the universe. More importantly, Hubble (and, independently, Belgian astronomer Georges Lemaître) discovered that the larger a galaxy's redshift, the faster it is receding from us, and the farther away it is, which allows us to measure the rate of expansion of the universe. This Hubble-Lemaître Law is therefore a critical piece of the expanding universe theory and Big Bang cosmology.

Edwin Hubble is considered by some to be one of the great American observational astronomers of the 20th century. His discovery of extragalactic variable stars ultimately led to an understanding of our expanding universe. In just a ten-year period, from 1923 to 1933, Hubble not only confirmed that spiral nebulae were external galaxies, he developed a general classification of galaxies and discovered the expansion of the universe (including the relationship between redshift and distance), leading to today's Big Bang cosmology. Few other astronomers, besides Copernicus or Galileo, have had such a revolutionary effect on our knowledge of the universe.

I encourage everyone to get out on the next clear night and try your hand at finding and observing the Andromeda and Triangulum Galaxies, M31 and M33. And while doing so, think about the man whose observation that October night, just one hundred years ago, led to the Big Bang theory: Edwin Hubble, the surveyor of the universe! ✶

Larry McHenry's website is stellar-journeys.org.

FURTHER READING:

Hubble, E. (1920) "Photographic Investigations of Faint Nebulae." *Publications of the Yerkes Observatory, adsabs.harvard.edu/full/1920PYer0...4....2H.*

Mayall, N. U. (1970) "Edwin Powell Hubble, 1889–1953." National Academy of Sciences, *www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/hubble-edwin.pdf* .

The Case of the MISSING MATTER

OBSERVING THE MYSTERIOUS NGC 1052-DF2

By Dave Tosteson

In 2013, Roberto Abraham of the University of Toronto and Pieter van Dokkum of Yale developed and commissioned a new type of telescope, with the goal of imaging extremely faint galaxy structure. Their creation, the Dragonfly Telephoto Array, was an innovative design combining multiple Canon 400 mm f/2 telephoto lenses, covered by "nano-fabricated coatings with sub-wavelength structure on optical glasses" to greatly reduce "scattered light and internal reflections" and allow a higher throughput of light. Housed at New Mexico Skies, with its wide array of internet-accessible instruments supported by an experienced technical staff, the initial results showed the array was "ten times more efficient than its nearest rival" according to its inaugural news release ("Project Dragonfly"). Its starting complement of three lenses has been gradually increased to 10, then 24 and 48, with plans to add another 120 lenses.

The 24-lens iteration of the Dragonfly Array. Image by Pieter van Dokkum, Yale University; website at www.dragonflytelescope.org.

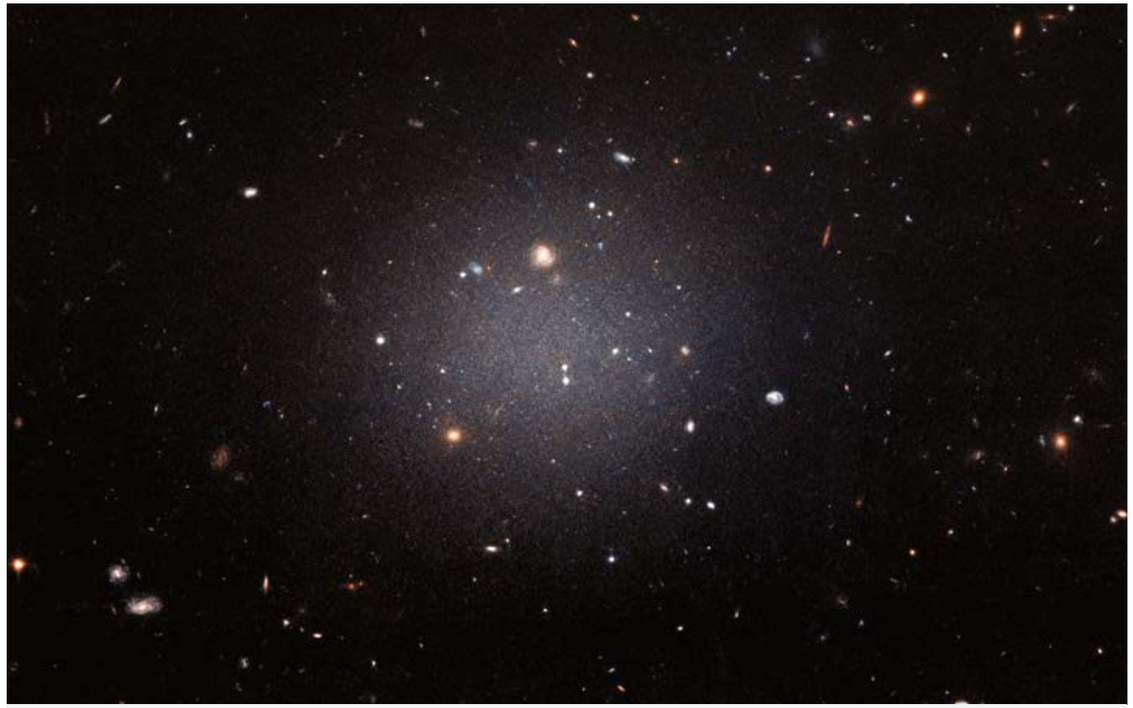
Igor Karachentsev from Russia's Special Astrophysical Observatory identified a faint galaxy in Cetus near NGC 1052. Van Dokkum's group imaged this area in 2018 with the Dragonfly Array and suspected it had an unusual nature. They said it appeared as a collection of point sources on the Sloan Digital Sky Survey (SDSS), but with Dragonfly it was more of a low-surface-brightness object with substructure. They did follow up imaging of its compact structures using Keck and Hubble. Its size and surface brightness resembled some nearby dwarf spheroidal galaxies, such as those around M101, but its stars could not be resolved with Hubble, so it had to be much farther than Messier's large spiral. Subsequent distance measurements placed it at 60 million light-years away.

With its low surface brightness and relatively large size (15,000 light-years across) the researchers called it NGC 1052-DF2. This "ultradiffuse galaxy" (UDG) had a stellar mass of 2×10^8 solar, with a luminosity of 1.1×10^8 solar. Spectroscopy of the ten compact objects within its boundaries using HST found them compatible with globular clusters seen at similar distances. But these were all much brighter than average globulars. They were more on the scale of Omega Centauri, the Milky Way's largest and brightest, which is likely the core of a captured dwarf galaxy. The big surprise was that their velocities appeared to be much lower than expected. In our Local Group of about 80 galaxies, those with similar stellar masses had velocities ten times higher, 32 km/s vs. 3.2 km/s. DF2's low globular velocities should not have been possible unless the *total* mass of the Dragonfly galaxy was much lower than all other known similar galaxies. The only explanation available seemed impossible: that it contained almost no dark matter!

This result, published in the March 29, 2018, issue of *Nature*, shocked the astronomical world. It even made headlines in mainstream media, as it defied the long-held process of how galaxies were built. The leading theory of cosmology, lambda cold dark matter (ΛCDM), stated that galaxies were formed on a substrate of dark matter, from the "ground up," so to speak. Basically, you couldn't make a galaxy if you didn't have a dark matter foundation.

But there it was. The dilemma seemed to worsen with the discovery of a congener, NGC 1052 DF-4, in March 2019. Van Dokkum and his group welcomed a second member to this mysterious group, because having a single example of anything makes one wonder if it is some kind of mistake or misunderstanding. Another example legitimizes the first, and invites different voices to weigh in to help resolve the dilemma.

How was this controversy to be unraveled? What new theory or evidence would break the deadlock between the standard ideas of how galaxies form and grow, and the findings showing there was essentially no dark matter within them? The key, as for most mysteries, was more evidence. Mireia Montes of the Space Telescope Science Institute and her group used deep imaging of NGC 1052-DF4 to show that it had two short tidal tails proceeding east and west in a spiraling manner. This type of structure, seen in many Hubble images of interacting galaxies, particularly throughout Arp's catalog of peculiar galaxies, are drawn out as two galaxies pass each other. The most famous example is the Antennae, NGC 4038 and 4039.



Hubble Space Telescope image of NGC 1052-DF2. Credit: NASA, ESA, and P. van Dokkum (Yale University)

Such encounters are known to separate dark matter from stars, since the latter are more centrally located and strongly held by gravity. The removal of their dark matter occurs from the outside of these dwarf galaxies, with the centrally located stars initially shielded from the process. Numerical simulations by Rory Smith of Yonsei University in Seoul in 2016 showed that, for dwarf galaxies in clusters, once tidal forces have taken 85–90 percent of the dark matter, significant star-stripping occurs. In NGC 1052-DF4, the fraction of its stellar mass in the tails is only 7 percent, meaning 93 percent is still bound to the galaxy. This is in contrast to the only 1 percent of its original dark matter that is still bound, so we are seeing it at the transition point just before many of its stellar members would start to be lost. Van Dokkum and his colleagues reasoned that this tidal force is the likely cause of why NGC 1052-DF2 and -DF4 are lacking dark matter: they have been tidally stripped of it through interactions with surrounding large galaxies. In the case of DF4, the nearby spiral NGC 1035 is the likely thief.

There is a second type of galaxy that has no dark matter. The youngest ones in the Universe are born through the debris of tidal interactions between spirals, when swirling gravity forms small "tidal dwarf galaxies," or TDGs. There are two at the western end of NGC 4038 and 4039's southern tail, and many can be seen in the tails of Arp-Madore (AM) 1353-272. I viewed the Antennae's TDGs in 1995 with my 25-inch reflector, and have seen numerous others, particularly within the complex interactions of Stephan's Quintet. These newborns, created from only the disks of the spiral galaxies as is "plane" to see, are free of dark matter. Stars and gas within spirals' bulges and halos, and elliptical galaxies, along with all their attendant dark matter, do not contribute to the formation of tidal dwarfs because of their different orbital dynamics.

During the 2022 Okie-Tex Star Party, I had a chart and image of NGC 1052-DF2 from the POSS 2 red plate, where the UDG appeared as a collection of faint stellar dots one arcminute wide. With my 25-inch f/5 reflector and a 9 mm Type 6 Nagler eyepiece giving 353×, the galaxy was noted relatively quickly in very good skies. The sighting was confirmed by my friend Tim Parson. I rated this as readily seen with direct vision and, seeing how faint it was on the POSS, I was surprised at its ready visibility. Next time you're in the area, take a look at these galaxies to appreciate the complex, subtle drama playing out in the deep Cetacean sky. ✶

NGC 1052-DF2: 02h 41m 46.8s, -08d 24m 12s.

NGC 1052-DF4: 02h 39m 15s, -08d 07m 00s.

REFERENCES:

Bounaud: *Advances in Astronomy* 2010 (3); arXiv:0907.3831.

Karachentsev et al.: *A&AS* 145, 415 (2000).

Montes et al.: *ApJ* 904, 114 (2020).

"Project Dragonfly," *Eos Magazine, eos-magazine.com/news/project-dragonfly-exploring-galaxies.html*

Smith et al.: *ApJ* 833, 109 (2016).

van Dokkum et al.: *Nature* 555 (7698), 629 (2018).

GALLERY

All images are ©2023 by their credited creators. Some are shown slightly cropped. Images are processed by *Reflector* staff for better contrast and tonal range on the printed page.

This page top: **Dan Crowson** (Astronomical Society of Eastern Missouri) captured this image of NGC 6712 with an Astro-Tech AT12RCT and a SBIG STF-8300M camera from DSNM in Animas, New Mexico.

This page bottom: **Ernie Jacobs** (Buffalo Astronomical Association) captured this nice image of the Iris Nebula with a Explore Scientific Essential Series ED80 Air Spaced Triplet and a ZWO ASI2600MC camera from his home in western New York.

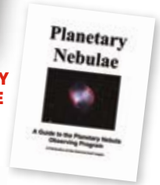
Next page top: **Bernard Miller** (East Valley Astronomy Club) captured this image of NGC 4631 with a PlaneWave 17-inch CDK and an FLI 16803 CCD camera from his observatory in Animas, New Mexico.

Next page bottom: **Ernie Jacobs** (Buffalo Astronomical Association) captured this nice image of the M101 with a Explore Scientific Essential Series ED80 Air Spaced Triplet and a ZWO ASI2600MC camera from his home in western New York.

SHOP OUR STORE

FOR WIDE VARIETY OF CLOTHING, BOOKS, HATS, & MORE—FAR TOO MUCH TO SHOW IN THIS AD!

NEW MANUAL! SUPPORTS ALL AL LUNAR OBSERVING PROGRAMS!
$20 PLUS $7 S&H



PLANETARY NEBULAE
$19 PLUS $6 S&H

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

ASTRONOMICAL LEAGUE ASTRONOMICAL IMAGING JOURNAL
$16 PLUS $6 S&H

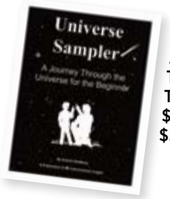
ASTRONOMICAL LEAGUE BASEBALL HAT
EMBROIDERED LOGO, ADJUSTABLE; ROYAL BLUE, MAROON, KHAKI, NAVY; $18 PLUS $5 S&H

ASTRONOMICAL LEAGUE SPORTSMAN'S BUCKET HAT
EMBROIDERED LOGO, S/M OR L/XL; KHAKI ONLY
$22 PLUS $5 S&H

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

MARS – AN OBSERVING GUIDE
A SYSTEMATIC PROGRAM STUDY OF THE RED PLANET.
$20 PLUS $7 S&H

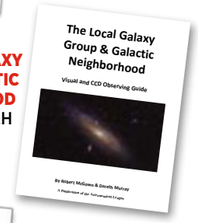
A PATHWAY TO THE STARS
THIS MANUAL IS A GREAT INTRODUCTION TO ASTRONOMY FOR THE NEW ASTRONOMER.
$10 PLUS $4 S&H



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

MESSIER OBJECTS
A BEGINNER'S GUIDE
$8 PLUS $4 S&H

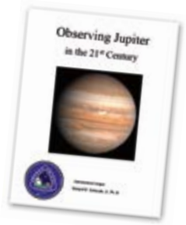
MATH FOR AMATEUR ASTRONOMERS
$15 PLUS $5 S&H



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

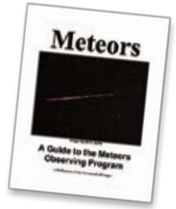
CARBON STARS
A GUIDE TO THE CARBON STAR OBSERVING CLUB
$12 PLUS $4 S&H

OBSERVING JUPITER IN THE 21ST CENTURY
$14 PLUS $5 S&H



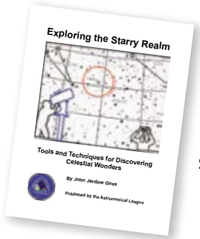
THE HERSCHEL II OBSERVING PROGRAM
$18, PLUS $7 S&H

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



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

GLOBULAR CLUSTERS
$16 PLUS $5 S&H



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

HERSCHEL 400
NOW REVISED AND EXPANDED
$16 PLUS $6 S&H

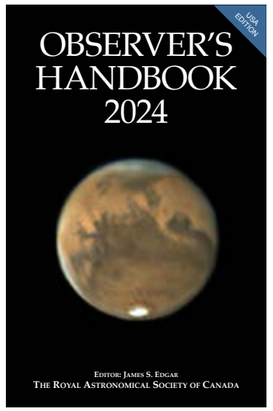
NEW!

HIGH QUALITY ENAMEL & BRASS PIN WITH ECLIPSE PHOTO.
$6, PLUS $4 S&H.
QUANTITY DISCOUNTS FOR 10 OR MORE.
1.25" WIDE X 1" TALL (SHOWN ACTUAL SIZE).

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

ROYAL ASTRONOMICAL SOCIETY OF CANADA

BEST PRICES AROUND ON RASC OBSERVERS' RESOURCES!



OBSERVER'S HANDBOOK

The popular 350–page classic in its 116th Year.
Special pricing for 2023 USA edition!
Contents include • Basic Astro Data • Planets • Optics and Observing • The Sky Month by Month • Eclipses • The Moon • Time (civil, astronomical, standards, & more) • The Sun • Dwarf and Minor Planets • Meteors, Comets, and Dust • Stars • The Deep Sky

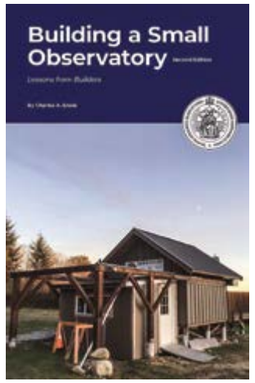
$27 EACH + $7 S+H
ORDERS OF 10 OR MORE: $26 EACH WITH FREE SHIPPING!

EXPLORE THE UNIVERSE GUIDE

A PERFECT GUIDE FOR THOSE LEARNING THEIR WAY AROUND THE NIGHT SKY
$23 PLUS $5 S+H

STAR FINDER

DISCOVER THE NIGHT SKY WITH THIS AFFORDABLE, EASY TO USE COMPACT PLANISPHERE
$2 PLUS $1 S+H



BUILDING A SMALL OBSERVATORY

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

$23 PLUS $5 S+H

OBSERVER'S CALENDAR

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

$21 EACH + $7 S+H
ORDERS OF 6 OR MORE: $19 EACH WITH FREE SHIPPING!

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

Observing Awards

Active Galactic Nuclei Observing Program

No. 34-I, **Terry Trees**, Amateur Astronomers Association of Pittsburgh

Advanced Binocular Double Star Observing Program

No. 56, **Brian McGuinness**, Northern Colorado Astronomical Society; No. 57, **Michael McShan**, Oklahoma City Astronomy Club; No. 58, **Michael Blase**, Olympic Astronomical Society

Arp Peculiar Galaxies Northern Observing Program

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

Arp Peculiar Galaxies Southern Observing Program

No. 22, **Jeffrey Corder**, Ancient City Astronomy Club

Asteroid Observing Program

No. 71, **Marty Hendrix**, Regular, Northeast Florida Astronomical Society; No. 72-I, **Russell F. Pinizzotto**, Regular, Southern Maine Astronomers; No 74, **Bernard Venasse**, Gold, Lifetime Member

Binocular Messier Observing Program

No. 1249, **Michael Babnick**, Colorado Springs Astronomical Society; No. 1250, **Nathan Babnick**, Colorado Springs Astronomical Society; No. 1251, **Carol Young**, Colorado Springs Astronomical Society; No. 1252, **Jeremy Mullican**, Lifetime Member; No. 1253, **Karl A. Schultz**, Central Arkansas Astronomical Society; No. 1254, **Ronan Kerr**, Austin Astronomical Society

Caldwell Observing Program

No. 32, **Eric Edwards**, Gold, Albuquerque Astronomical Society; No. 290, **Larry Elsom,** Silver, Member-at-Large; No. 291, **Peter K. Detterline**, Silver, Member-at-Large; No. 292, **Janet Rush,** Silver, Delaware Valley Amateur Astronomers; No. 293, **Don Martin**, Silver, Von Braun Astronomical Society

Carbon Star Observing Program

No. 152, **Richard Wheeler,** Northeast Florida Astronomical Society

Citizen Science Special Program

Dan Crowson, Astronomical Society of Eastern Missouri, Int'l. Astron. Search Collab., Active, Gold Class 5; **Dan Crowson**, Astronomical Society of Eastern Missouri, Daily Minor Planet, Active, Bronze; **Dan Crowson**, Astronomical Society of Eastern Missouri, Daily Minor Planet, Active, Silver; **Dan Crowson**, Astronomical Society of Eastern Missouri, Daily Minor Planet, Active, Gold Class 1, 5, 10, 15; **Al Lamperti**, Delaware Valley Amateur Astronomers, Galaxy Zoo, Weird & Wonderful, Active, Gold Class 14; **Al Lamperti**, Delaware Valley Amateur Astronomers, Active Asteroids, Active, Gold Class 120; **Al Lamperti**, Delaware Valley Amateur Astronomers, Star Notes, Active, Gold Class 239; **Brad Young**, Astronomy Club of Tulsa, Variable Stars, Observational, Gold Class 7, 8; **Brad Young**, Astronomy Club of Tulsa, Variable Galaxies, Observational, Bronze

Comet Observing Program

No. 62, **Stanley Davis**, Gold, Oklahoma City Astronomy Club; No. 63, **David Babb**, Gold, Member-at-Large; No. 133, **Randy Carter**, Silver, Echo Ridge Astronomical Society; No. 134, **Richard Wheeler**, Silver, Ancient City Astronomy Club; No. 135, **Laurie V. Ansorge**, Silver, Lifetime Member; No. 136, **Lauren Rogers**, Silver, Escambia Amateur Astronomers Association

Constellation Hunter Northern Skies Observing Program

No. 301, **Stephen R. Hildenbrandt**, Miami Valley Astronomical Society; No. 302, **Darcy Howard**, Central Arkansas Astronomical Society

Constellation Hunter Southern Skies Observing Program

No. 13, **Mark Simonson**, Everett Astronomical Society; No. 14, **Eric Edwards**, Albuquerque Astronomical Society

Dark Nebula Observing Program

No. 40, **Peter K. Detterline**, Member-at-Large; No. 41-I, **Daniel Beggs**, Albuquerque Astronomical Society

Deep Sky Binocular Observing Program

No. 446, **Jill Sinkwich**, Member-at-Large; No. 447, **Larry Elsom**, Member-at-Large

Double Star Observing Program

No. 705, **Michael Blase**, Olympic Astronomical Society; No. 706, **Karl Schultz**, Central Arkansas Astronomical Society; No. 707, **Rod Hughes**, Von Braun Astronomical Society

Flat Galaxy Observing Program

No. 47-I, **Terry Trees**, Honorary, Amateur Astronomers Association of Pittsburgh

Foundations of Imaging Observing Program

No. 10, **Sam Pitts**, Temecula Valley Astronomers

Galaxy Groups and Clusters Observing Program

No. 55-I, **Terry N. Trees**, Amateur Astronomers Association of Pittsburgh; No. 56-I, **Steve Boerner**, Member-at-Large

Herschel 400 Observing Program

No. 653, **Emory Horvath,** Member-at-Large; No. 654, **Jerelyn Ramirez**, Kansas Astronomical Observers; No. 655, **Don Martin**, Von Braun Astronomical Society

Herschel II Observing Program

No. 121-Manual, **Robert Kacvinsky**, Prairie Astronomy Club; No. 122-Manual, **Alfred Schovanez**, Astronomical Society of Eastern Missouri; No. 123-Manual, **Mike Reitmajer**, Rose City Astronomers; No. 124, **Eric Edwards,** Albuquerque Astronomical Society

Herschel Society Observing Program

Paul Harrington, Member-at-Large, Silver; **Matt Orsie**, Tri-State Astronomers, Gold; **Terry Trees**, Amateur Astronomers Association of Pittsburgh, Gold

Imaging – Messier Observing Program

No. 1, **Laurie V. Ansorge**, Lifetime Member

Library Telescope Observing Award

No. 33, **Krista Lemoine**, Silver, Salt Lake Astronomical Society; No. 34, **Allen Lee**, Silver and Gold, Central Arkansas Astronomical Society

Lunar Evolution Observing Program

No. 29-I, **Jeffrey Corder**, Ancient City Astronomy Club; No. 30, **Ted Forte**, Huachuca Astronomy Club; No. 31-I, **Brad Payne**, Northern Virginia Astronomy Club; No. 32-I, **Mark L. Mitchell**, Delaware Astronomical Society

Lunar Observing Program

Nos. 1207 and 1207-B, **Ian Wymore**, Denver Astronomical Society; No. 1208, **Anna Daly**, Kalamazoo Astronomical Society; Nos. 1209 and 1209-B, **Michael Babnick**, Colorado Springs Astronomical Society; Nos. 1210 and 1210-B, **Nathan Babnick**, Colorado Springs Astronomical Society

Lunar II Observing Program

No. 138, **Bernard Venasse**, Lifetime Member

Mentor Observing Award

John Land, Astronomy Club of Tulsa

Messier Observing Program

No. 2897, **Rick Ray**, Honorary, North Houston Astronomy Club; No. 2905, **Pete Hermes**, Honorary, Tucson Amateur Astronomy Association; No. 2906, **Michael Babnick**, Honorary, Colorado Springs Astronomical Society; No. 2907, **Nathan Babnick**, Honorary, Colorado Springs Astronomical Society; No. 2908, **David Berish**, Honorary, Greater Hazleton Area Astronomical Society; No. 2909, **Brian Hayward**, Regular, Rose City Astronomers; No. 2910, **Jeremy Mullican**, Honorary, Lifetime Member

Meteor Observing Program

No. 79, **Bernard Venasse**, Honorary, Lifetime Member

Multiple Star Observing Program

No. 22, **Jeffrey S. Moorhouse**, La Crosse Area Astronomical Society

Open Clusters Observing Program

No. 111-I, **Daniel Beggs**, Albuquerque Astronomical Society, Advanced Imaging

Outreach Observing Award

No. 1235, **Rich Dollish**, Stellar, Amateur Astronomers Association of Pittsburgh; No. 1254, **David R. Catlin**, Master, Boise Astronomical Society; No. 1299, **Richard Benson**, Stellar, Rio Rancho Astronomical Society; No. 1301, **Caitlin Mallory,** Master, Colorado Springs Astronomical Society; No. 1357, **John Strebeck**, Outreach, Stellar, Master, St. Louis Astronomical Society; No. 1358, **Kathleen Strebeck**, Outreach, Stellar, Master, St. Louis Astronomical Society; No. 1374, **Mike Donaldson**, Outreach, River Bend Astronomy Club; No. 1375, **Dee Friesen**, Outreach, Albuquerque Astronomical Society; No. 1376, **Ronald Monti**, Outreach, Stellar, Master, Raleigh Astronomy Club; No. 1377, **Jeremy Gaulke**, Outreach, Tri-State Astronomers; No. 1379, **Lindsey Benson**, Outreach, Rio Rancho Astronomical Society; No. 1380, **Tom Campbell**, Outreach, Stellar, Master, Brazos Valley Astronomy Club; No. 1381, **Richard Lighthill**, Outreach, Huachuca Astronomy Club; No. 1382, **Pam Kollar**, Outreach, Popular Astronomy Club, Quad Cities

Planetary Nebula Observing Program

No. 105, **Alan Scott**, Advanced, Manual, Albuquerque Astronomical Society; No, 106, **Don Martin**, Advanced, Von Braun Astronomical Society

Sketching Observing Program

No. 61, **Daniel Beggs**, Albuquerque Astronomical Society; No. 62, **Marie Lott**, Atlanta Astronomy Club

Solar Neighborhood Observing Program

No. 9, **Viola Sanchez**, Eyes Only, Albuquerque Astronomical Society; No. 10, **David Wickholm,** Eyes Only, San Antonio Astronomical Association; No. 11, **Michael Blase**, Eyes Only, Olympic Astronomical Society; No. 12, **Robert Togni**, Eyes Only, Central Arkansas Astronomical Society; No. 13, **Mark Simonson**, Eyes Only, Everett Astronomical Society; No. 8, **Stephen Nugent**, Binocular, Member-at-Large; No. 9, **Lisa Wentzel**, Binocular, Twin City Amateur Astronomers; No. 10, **Viola Sanchez**, Binocular, Albuquerque Astronomical Society; No. 11, **Jeffrey Corder**, Binocular, Ancient City Astronomy Club; No. 12, **Michael Blase**, Binocular, Olympic Astronomical Society; No. 13, **Robert Togni,** Binocular, Central Arkansas Astronomical Society; No. 14, **David Wickholm**, Binocular, San Antonio Astronomical Association

Solar System Moon Challenge

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

Solar System Observing Program

No. 214-B, **Stephen R. Hildenbrandt**, Miami Valley Astronomical Society; No. 215-B, **Michael Blase**, Olympic Astronomical Society; No. 216, **Stephen R. Hildenbrandt**, Miami Valley Astronomical Society

Southern Skies Binocular Observing Program

No. 107, **Eric Edwards**, Albuquerque Astronomical Society; No. 108, **Mark Simonson**, Everett Astronomical Society; No. 109, **Michael Blase**, Olympic Astronomical Society

Southern Sky Telescopic Observing Program

No. 66, **Mark Simonson**, Everett Astronomical Society; Nos. 67 and 67-I, **Peter K. Detterline**, Member-at-Large

Stellar Evolution Observing Program

No. 102, **Daniel Beggs,** Albuquerque Astronomical Society; No. 103, **Jeffrey Corder,** Ancient City Astronomy Club

Sunspotter Observing Program

No. 229, **James T. McLaughlin**, Auburn Astronomical Society; No. 230-I, **Aaron Clevenson**, North Houston Astronomy Club; No. 231, **Darcy Howard**, Central Arkansas Astronomical Society

Two in the View Observing Program

No. 59, **Viola Sanchez**, Albuquerque Astronomical Society

Urban Observing Program

No. 239, **Dave Tosteson**, Minnesota Astronomical Society

Variable Star Observing Program

No. 58, **John Sikora,** Lifetime Member

Youth Astronomer Observing Program

No. 1, **Julia Brown**, Silver, Independent; No. 1, **Max Hunter**, Silver, Independent; No. 1, **Jo Jakubowski**, Silver, Independent; No. 1, **Zethos Sibbald**, Silver, Independent; No. 1, **Shiyanne Weinzetl**, Silver, Independent

Master Observer Progression

OBSERVER AWARD

Glynn Germany, Rio Rancho Astronomical Society; **Pete Hermes**, Tucson Amateur Astronomy Association; **Michael R. Martin**, Roanoke Valley Astronomical Society; **Karl A. Schultz**, Central Arkansas Astronomical Society

MASTER OBSERVER AWARD

No. 260, **Jerelyn Ramirez**, Kansas Astronomical Observers

BINOCULAR MASTER AWARD

Michael Blase, Olympic Astronomical Society; **Dick Francini**, Neville Public Museum Astronomical Society; **Stephen R. Hildenbrandt**, Miami Valley Astronomical Society

MASTER IMAGER AWARD

Aaron Clevenson, North Houston Astronomy Club

MASTER OBSERVER AWARD – SILVER

Daniel Beggs, Albuquerque Astronomical Society; **Marie Lott**, Atlanta Astronomy Club; **Bernard Venasse**, Lifetime Member

MASTER OBSERVER AWARD – GOLD

Peter K. Detterline, Member-at-Large; **Brad Payne**, Northern Virginia Astronomy Club

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

NON-PROFIT
ORGANIZATION
U.S. POSTAGE
PAID
Tucson, AZ
permit #271