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Vol. 76, No. 3 JUNE 2024

Reflector

LEAGUE OFFICER NOMINATIONS

(ALMOST) ALL THE MESSIER OBJECTS PHOTOGRAPHED IN ONE VERY BUSY EVENING

HALTON ARP'S PECULIAR GALAXIES

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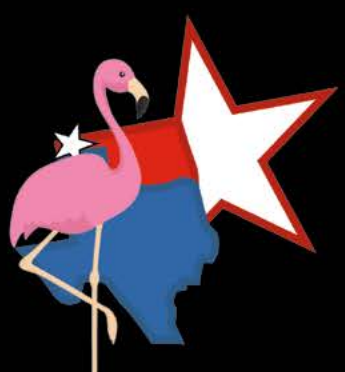

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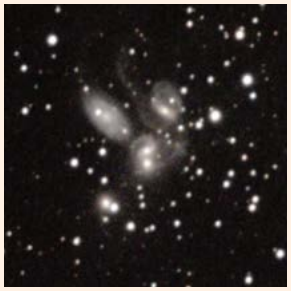

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Gregg Ruppel *(Tucson Amateur Astronomy Association) captured this image of M24 from his remote observatory at Dark Sky New Mexico in Animas, New Mexico, with an ASA 10N f/3.8 Astrograph and SBIG STL-11000M CCD camera. Our cover shows only a portion of the image, which can be seen complete at* greggsastronomy.com/IMAGES/m24-RGB.jpg.

Reflector

The Astronomical League Magazine

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A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION
To promote the science of astronomy

- by fostering astronomical education,
- by providing incentives for astronomical observation and research, and
- by assisting communication among amateur astronomical societies.

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

Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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***REFLECTOR* AND CLUB ROSTER DEADLINES**

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

LETTERS TO THE EDITOR

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

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Erratum

In our March issue, we erred in crediting one of the co-creators of the cover image of NGC 7822. His name is Mark Theissen, not Matt. We regret the error.

To the Editor

The March 2024 issue of the *Reflector* has an article, "Astronomical Cause and Effect Part 2," by Peggy Walker. She described an experience that followed an astronomy night that the Broken Arrow Sidewalk Astronomers held in Muskogee, Oklahoma. Videos of the event were posted online. The videos showed "children all playing together and getting along."

The article mentioned that event contact Charles Crawford received a call from a Chamber of Commerce member. This person accused Crawford of altering the video. The caller's reasoning was that "students and their parents did not usually integrate as a community…tending to remain within their own neighborhood groups."

This report was both upsetting and encouraging to read. It is good that the *Reflector* published this. It is sad to see such blatant racism in our nation today. The meaning of the complaint is obvious and terrible. Some people will never learn.

It was also important that Walker reported on this. She further wrote that word about this confrontation became public. Several community leaders, including high school teachers, organized a public event to support this astronomy outreach. What could have been a terrible, divisive complaint turned into an opportunity for community healing.

I assist with public observing at Floyd Bennett Field in Brooklyn, New York. People from many ethnic groups who speak many different languages attend. This is a normal and happy part of running these public events. Recently I heard people speaking English, Spanish, Chinese, and Russian all enjoying themselves together.

Note that Broken Arrow is a suburb of Tulsa. Muskogee is a few miles away. It seems that the scars of past violence and bigotry are still present. However, people are working to overcome this and to come together as a single community. There is hope.

—Stephen Lieber

Star Beams

NATURE SHARES ANOTHER INCREDIBLE SHOW WITH US

This is a different type of Star Beams column this quarter. Once again, we are strongly reminded of the majesty of our celestial world. Seven years ago, in 2017, millions of people, astronomers and non-astronomers alike, shared this total solar eclipse phenomenon across the country. On April 8, we were honored with a repeat performance, this time with an added bonus of experiencing

Totality photo by Robert Walters

Carroll with Sue from the Hotel Staff and Jeanne from Wisconsin. Photo by Laura Light.

about twice the maximum length of totality along various parts of the path.

My family and I shared this unforgettable experience in Fairfield Bay, Arkansas, with astronomers, non-astronomers, and hotel staff, and including astronomers we have known for several years, such as a couple from Wisconsin. We also made many new friends who hailed from such localities as Georgia, Louisiana, Texas, Utah, New Mexico, the Potawatomi Nation, Oklahoma, North

Wisconsin friends Steve and Jeanne. Photo by Laura Light

Carolina, Connecticut, Missouri, and the host state of Arkansas.

One of the reasons why I became fascinated with the hobby many years ago was the peace and calm that I experience from interacting with both the night sky as well as the solar experience. People gathering to share a natural event without thinking about what makes us different, an activity that unifies us for a common purpose, is a truly beautiful experience.

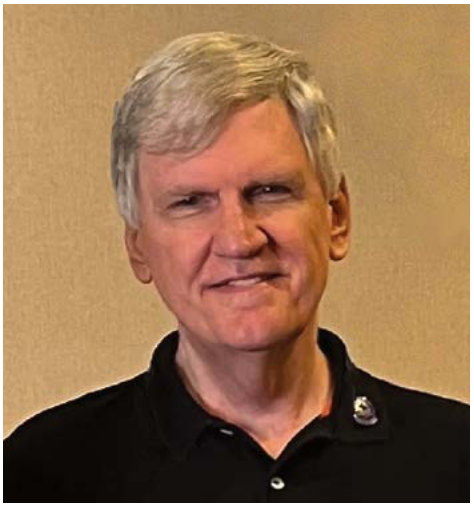
Keep exploring the cosmos!

—Carroll Iorg, President

Officer Candidate Bios

CHARLES E. "CHUCK" ALLEN III, CANDIDATE FOR PRESIDENT

Chuck Allen has served as League vice president for the last four years, overseeing eight youth and general award programs, co-chairing ALCon '21 Virtual, and chairing the recently completed League bylaws revision project. A League Lifetime Member, he has given previous service as League



president (1998–2002), vice president (1994–98), secretary (2019–20), and Great Lakes chair (1991–98). He also proposed and developed the League's 32-year-old National Young Astronomer Award and received the G. R. Wright Award for service in 1998.

An avid astronomer from age seven, Chuck holds the League's Master Observer Gold and Master Outreach awards, coordinates three League Observing Programs, has given 550 presentations to universities, schools, conventions, public events, and more than 27 League societies, and has made a combined 40 speaking appearances in Explore Scientific Global Star Parties and League Live events. Since 1996, he has researched and compiled the exhaustive League narrative, convention, and officer histories that appear on the website under "About Us."

Chuck is currently program director of the Evansville Astronomical Society, and past president of the Louisville Astronomical Society. He co-founded a major Indiana star party (now in its 34th year), served as a judge and lead judge for the Intel (now Regeneron) International Science and Engineering Fair (1995–2002), and currently serves as a best-in-fair judge for the Louisville Regional Science Fair.

Chuck hopes to enhance our website's usefulness to member societies, stimulate regional activity, trademark the League's name and logo, protect League intellectual property, and explore ways to improve the profitability of League conventions.

MAYNARD PITTENDREIGH, CANDIDATE FOR PRESIDENT

I believe there are qualifications that a president of the Astronomical League should have: experience in the leadership of the AL, being an avid observer, and being active in outreach.

I'm currently the executive secretary. As such, I have experience working closely with other officers, the executive committee, and the council. I served as the chairperson of ALCon 2019. I am one of the five National Observing Program Directors members, which oversees and coordinates the work of our many observing programs.

I have been an avid observer since my youth. I have 126 observing awards with the AL, so I'm obviously obsessed with observing and being challenged in new areas of astronomy.

I have been active in outreach since my teens, setting up my telescope in the parking lot of our high school football games. I currently serve as the coordinator of our AL Observing Award program.

If elected president, I have several goals for the future of our Astronomical League. First, I would like to work to encourage youth safety policies for our clubs and members, especially when we do outreach events. Second, I believe in the importance of encouraging our members in planned giving so that we continue to build up our trust fund. Third, we are just beginning to venture into increasing international memberships and clubs in other nations. Fourth, I would like to see us continue to grow in membership numbers, with increases that include young and old, men and women, and various races and cultures.

TERRY MANN, CANDIDATE FOR VICE PRESIDENT

Terry is currently the Astronomical League secretary. She also previously served as secretary (1997–2001), vice president (2002–2006), and president (2006–2010). Terry is the chair of the Great Lakes Region (2018–present), and serves as trustee of the Astronomical League.

Terry received the G. R. Wright Award for service in 2004, and the Hans Bauldauf Award in 2007 for significant contributions relating to astronomy. She co-chaired ALCon 2011 held at Bryce Canyon National Park, and co-chaired ALCon 2021 Virtual.

Terry does the programing for and co-hosts the Astronomical League Live program once a month. The March 2024 program was the 36th. This allows the League to reach a global audience. Members who can't travel to League events regularly view the program.

She also coordinates the speakers from the Astronomical League for the Explore Scientific Global Star Parties. Terry has spoken at various conferences, star parties, and events. In 2023/2024 she gave multiple talks to emergency services about problems that arose at the 2017 total solar eclipse.

Terry is an astro-imager. Her first image was of the Moon when she was 8 years old. She "appropriated" her father's Polaroid camera to take that picture.

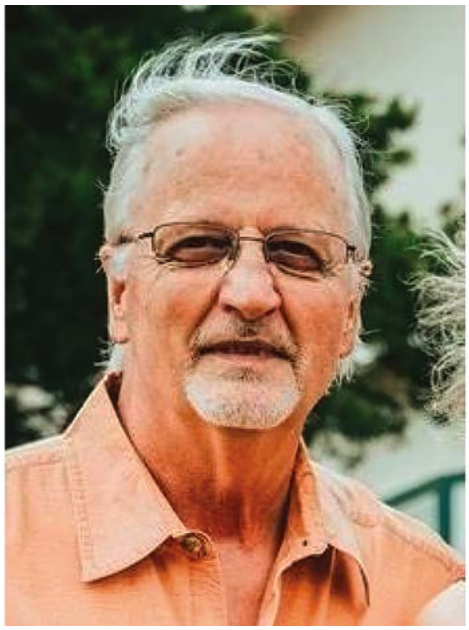
Terry holds a bachelor of science management degree from Indiana Wesleyan University.

She wants to see the League continue to do virtual programming, in-person education, and

outreach to support all clubs, members, and the public. She believes that it is vital for the League to support its members and the public with information about the League, astronomy, and space-related events.

MICHAEL G. "MIKE" COUCKE, CANDIDATE FOR TREASURER

I am a retired systems/software engineer from



Lockheed Martin, having worked on the development of the F-16, F-22, and F-35 aircraft. I was born and raised in Detroit, but currently live with my wife of 52+ years on our 160-acre farm in southwestern Oklahoma.

I have a B.S. degree in astronomy from the University of Arizona (1973) and briefly worked as an undergraduate research assistant at Kitt Peak National Observatory (1972–73) under the mentorship of Dr. Arthur A. Hoag. I have also completed some graduate studies in computer science at the University of Texas at Arlington (1979–92).

I have been an avid stargazer since 1962, after my brother received a 60 mm refractor at Christmas. One look at Saturn and its rings in a telescope was all it took to get me hooked! I currently have a small observatory that houses a modest 8-inch catadioptric telescope that needs more frequent utilization. More information about me can be found on my public Facebook page *(www.facebook.com/mike.coucke).*

I am an AL Patron Member and previously served as AL treasurer (1985–86) and advertising representative for the *Reflector*. I also served as commissioner (president) of the General Dynamics Astronomy Club (1979–81) in Fort Worth, Texas. I currently serve as the treasurer for the Oklahoma Chapter of the Sierra Club's political action committee.

I am pleased with the progress the League has achieved over the years. I have the time, energy, and desire to serve the League again as its treasurer.

Night Sky Network

SUMMER ASTROPHOTOGRAPHY

Now that we've fully recovered from the solar eclipse, it's time to turn our attention back to the night sky! We're in the prime season for observing and astrophotography. The dark dust lanes of our galactic center make an easy target in dark skies for even the most novice of photographers. No dedicated camera? No problem! You can learn smartphone astrophotography practices at *go.nasa.gov/4csYeB3*. If you own a DSLR (digital single-lens reflex) camera, and you want to get started, here are some high-level tips to get you started photographing the Milky Way:

SCHEDULE AROUND THE MOON

This may seem obvious, but you should avoid nights where you'll have the Moon in the sky and illuminated more than 5 percent, waxing or waning. Although it's a beautiful sight, if your goal is to photograph the Milky Way band, you'll want to avoid having the Moon visible above the horizon. And on the topic of horizons, you'll want to set up in a place with a low southern horizon and no trees or buildings in the way to get the best view.

BORTLE

The Bortle scale measures the sky's darkness, and knowing yours will help you be successful. There are a number of apps and websites that will help you determine the darkness of your preferred location. Although you can photograph the Milky Way band by Bortle 6, for best results, try to travel to a location of Bortle 4 or less.

GET SNAPPING

After setting your camera up on a sturdy tripod on a level location, make sure that:

You set your camera to manual with the ISO settings between 500 and 1600; your skies will determine the best ISO setting for you. And if the term ISO sounds familiar, it should – ISO stands for International Organization for Standardization, the same standardization that sets safety ratings for solar viewers!

When setting the exposure on your camera, be mindful. If you have a stationary tripod and set a long exposure, you will end up with star trails. But if your camera is set to a shorter exposure time, you will be able to snap short, beautiful bursts. Most cameras allow for exposure times of anywhere from a few seconds to 30 minutes.

Your camera is set to raw image format – this is best for processing the photos later in any software.

IT'S A PROCESS

There is a lot of trial and error with astrophotography, so be sure to have fun with it. Additionally, you can process your photos in software like GIMP, Photoshop, or PixInsight, to name a few.

Speaking of processing photos, the target for NASA's Summer 2024 Astrophoto Challenge is Cassiopeia A! This challenge is set for May 20–August 5, so flex those creativity muscles by joining in at *bit.ly/Summer24Astrophoto*, and be sure to create your own astrophotos this summer!

Beginners and experts alike will find a friendly community for tips and answers to your night sky photography questions over at Cloudy Nights: *bit.ly/DeepSkyStarterGuide.*

—Kat Troche

DarkSky Corner

When planning to update your outdoor lighting, or when building new construction, keep in mind DarkSky's Principles for Responsible Outdoor Lighting:

- *Is a proposed light useful?* Use a light only when it's needed.
- *Is the light properly targeted?* Aim the light downward to where it's useful.
- *Is the lighting low-level?* Use only the amount of light needed for the task at hand. Avoid over-lighting.
- *Is it controlled?* A light should only be on when it's needed.
- *Is it warm-colored?* Warm-colored lighting is more pleasing to the eye. Amber-toned lighting is preferred.

Keeping these principles in mind will go a long way to keeping our shared skies as dark as possible, and will save electricity (and money).

For more information, visit the DarkSky website: *darksky.org/resources/guides-and-how-tos/lighting-principles.*

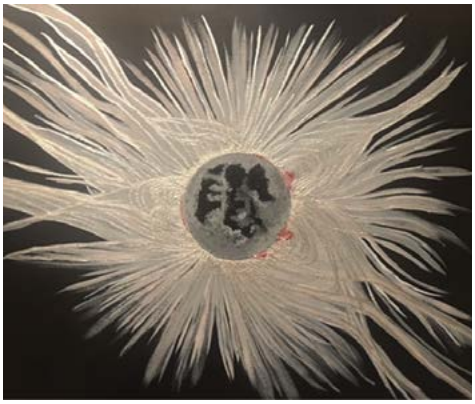
—Tim Hunter

Full STEAM Ahead

MY HELIOPHYSICS ARTWORK

A unique composite image of the 2017 Great American Eclipse was posted by *Space.com,* showing the lunar surface superimposed on the shadow with the extremely active corona in white. It became an inspiration for a 16- by 20-inch piece of artwork that was donated to the Winter Star Party and now resides in New York's Finger Lakes region. Although her husband had just won a telescope, the artwork's winner said that she felt she had won the best prize of the day. Upon returning home from Florida, I was informed by Charles Crawford that he was planning an eclipse event and that two-thirds of the student body from the Muskogee School for the Blind would be in attendance; he didn't know what he was going to do to accommodate them.

In the past I had generated many accessible



and tactile resources, so my immediate response was to make eclipse resources for the students. These are a model of the Sun's internal structure and atmosphere, smaller panels of the eclipse stages with log sheets to note time and temperature, a panel on the three types of eclipses, a 3- by 4-foot U.S. map of the two eclipses (2017 and 2024) and phases represented, and a panel of the *Space.com* image. As I painted the canvas, I wondered if the plasma between the radiant lines is an ionized electromagnetic field. So, to best replicate those, I twisted tule fabric for the field lines, raised metallic paint for the flares, silver pipe cleaners for the coronal loops, tule pieces between the field lines, a pearl beaded tule ring around the circular black glitter foam to delineate the Alfvén surface, and red gemstones for Baily's beads.

I conducted research to create notes for the teachers, which led me to Benjamin Boe and colleagues' 2020 paper from the *Astrophysical Journal.* The paper included images depicting the Sun's coronal magnetic field topology using RHT, rolling Hough transform field line tracing method. They processed the images with a Gaussian high-pass filter and enhanced the edges. I went down the rabbit hole and discovered other great papers – see the reference list below. At the penning of this article, the eclipse is yet to happen, and the students have not encountered the panels.

Although I will be at totality in Broken Bow, Oklahoma, my heart will be with the students who get to touch the eclipse and conduct science at the same time. I was promised videos and photos of their encounters and will happily share in the future.

Full STEAM ahead with a sunny disposition,

—Peggy Walker

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Yang, Z., et al. 2020. *Science* 369, 694. DOI: 10.1126/science.abb4462.

Deep-Sky Objects

A NICE GALAXY IN BERENICE'S HAIR

Coma Berenices is a faint constellation between Boötes and Leo. While Boötes hosts the bright star Arcturus and Leo contains the bright star Regulus, Coma Berenices has no bright stars. However, it contains a plethora of galaxies. The Virgo Cluster lies on the south edge of Coma Berenices, spanning both sides of the border with Virgo. The Coma Galaxy Cluster resides on the northeast side of Coma Berenices.

Just southwest of the Coma Cluster is an interesting galaxy, NGC 4725, which can be found 5.3 degrees southwest of the star Beta Comae Berenices and 9 degrees north-northwest of Alpha Comae Berenices. The galaxy is magnitude 9.2 and measures approximately 9.8 by 7.0 arcminutes in size. The galaxy is midway between edge-on and face-on. NGC 4725 lies 40 million light-years away. William Herschel discovered NGC 4727 on April 6, 1785. The star-like core and elongated shape of the galaxy are easily visible in an 8-inch telescope.

NGC 4725 is a peculiar intermediate spiral galaxy. Intermediate galaxies are in-between normal and barred spiral galaxies. NGC 4725 has a weak bar feature and a ring-like structure outside the barred region. The galaxy appears to have a single spiral arm that wraps more than halfway around the ring. The ring and spiral arm contain regions of new star formation. NGC 4725 is an active Type 2 Seyfert galaxy, and astronomers suspect it has a massive black hole in its core.

My image of NGC 4725 was taken with a Stellarvue 70 mm f/6 triplet refractor employing a 0.8× focal reducer/field flattener. The camera was an SBIG STF-8300C and the exposure was 80 minutes. In the image, slightly to the right of NGC 4725, is the smaller galaxy NGC 4712, a 13th-magnitude spiral galaxy. Approximately twice as far away, to the upper right of NGC 4725, lies NGC 4747, a 12th-magnitude barred spiral galaxy. Although NGC 4712 appears closer to NGC 4725 than NGC 4747 from our vantage point, NGC 4747 is actually much closer to NGC 4725 in three-dimensional space. NGC 4747 and NGC 4725 appear to be interacting galaxies. This interaction may explain the asymmetries in the ring and spiral arm of NGC 4725.

Below and to the right of NGC 4725 is the brightest star in the image star in the image, LW Comae Berenices. This star varies in brightness from magnitude 6.31 to 6.41 over a 15.8-day cycle. The faintest stars in the image are magnitude 16. There are scores of additional galaxies in the image; all but the three mentioned above appear as faint star-like dots. Those dots that are not galaxies are foreground stars residing in our home galaxy.

Clear spring nights allow the year's best viewing of uncountable distant galaxies in Coma Berenices and neighboring constellations. NGC 4725 is an easy find. After seeing it, take time to ponder the strangeness of this unique celestial island.

—Dr. James R. Dire

References

"NGC 4725." Spitzer Space Telescope, *www.spitzer.caltech.edu/image/sig05-011-ngc-4725.*

Wevers, B. M. H. R., et al. (1984). *A&A* 140, 125.

The 88th Stellafane Convention

August 1-4, 2024. Experience the **ORIGINAL STAR PARTY,**
held since 1926 at the storied home of the Springfield Telescope Makers!

KEYNOTE ADDRESS

"From ATM and Stellafane to Polishing Webb Mirrors" by **Tony Hull,** who supervised the polishing of the James Webb Space Telescope's mirrors. He will briefly talk about his connection to Stellafane and the world of amateur telescope making as a young man, then discuss his intimate involvement with the Webb and the challenges that were met in its creation.

"SHADOWGRAM" TALK

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

FINE OBSERVING

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

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

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TEEN ROBOTICS WORKSHOP

CAMPING

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

The Hartness House Workshop

ECLECTIC ASTRONOMY III

THURSDAY, AUGUST 1, 2024

This day-long conference will offer ten high-quality presentations on a range of astronomical subjects, with an opportunity to mingle with the speakers and other attendees at the historic **Hartness House Inn.** Registration for the HHW includes meals for the day and a cocktail hour. **The Hartness/Porter Museum of Amateur Telescope Making** will be open during the day.

The keynote speaker will be **Tony Hull,** of the University of New Mexico, who supervised the polishing of the James Webb Space Telescope's mirrors. He will talk about the images that the Webb has been bringing to the world since its commissioning.

Registration is separate from the Convention, with additional fees.

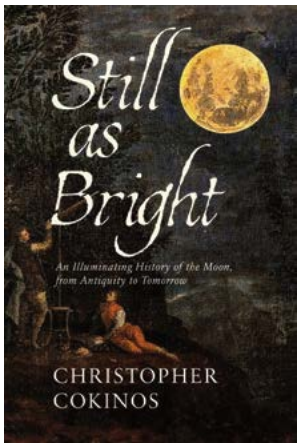
See the web page at the link below for registration information.

LEARN MORE AND REGISTER ONLINE STARTING IN EARLY MAY AT STELLAFANE.ORG/CONVENTION/2024/INDEX.HTML (OR SCAN THE QR CODE BELOW) REGISTER EARLY FOR BEST RATE!

PHOTO CREDITS: keynote panorama, Thomas Spirock; telescope competition, Richard Sanderson; Hartness House, Tyler Goodrich via Wikimedia Commons; Schupmann Telescope and Milky Way, Dennis di Cicco.

Still as Bright: An Illuminating History of the Moon, from Antiquity to Tomorrow

by Christopher Cokinos (Pegasus Books, 2024)



By Kristine Larsen

This series of personal essays connects vignettes from the author's life with astronomical history and his personal observations of the Moon. Along the way, Cokinos shares his reminiscences and experiences alongside those of scientists, astronauts, engineers, educators, and more through personal interviews.

Historical figures are brought to life through the reminiscences of those who knew them, archival materials, and their own words. The sometimes-rocky journey of humanity's understanding of our nearest cosmic neighbor is also nicely detailed. A particularly interesting example is a survey of past presumptions that the Moon is inhabited, what the author calls "a living Moon" (94). Cokinos focuses on the speculations of Franz von Paula Gruithuisen, perhaps not exactly a household name, who believed that lunar rilles and valleys were caused by the migrations of herds of animals. As Cokinos notes, Gruithuisen was "foreshadowing Percival Lowell's forthcoming arguments about Martians planning their canals to save a drouthy world" (120). In an 1824 article, the astronomer announced what he claimed was evidence of a city and temple on the Moon, claims that led to widespread derision in the astronomical community. Cokinos also connects the dots with the Great Moon Hoax, a series of pranked articles claiming that William Herschel's son John, a famed astronomer in South Africa, had discovered "conversing bat-men and blue unicorns" on the Moon (123).

A highly speculative chapter on the controversial subject of transient lunar phenomena (TLP) highlights the personal stories of Barbara Middlehurst and Winifred Cameron, and the intersections between sexism and skepticism in science. He appears sympathetic towards TLP proponents but does provide a balance of voices from both sides.

His visit to Cape Canaveral and Kennedy Space Center provides the opportunity to ponder the dark underbelly of the American space success, not only the well-known connection to Nazi scientists, but in particular the "V-2 slaves," concentration camp laborers who manufactured and assembled the rockets. Cokinos criticizes the sanitized early history of the U.S. space program and how these uncomfortable truths are largely ignored by exhibits at Cape Canaveral and elsewhere, further perpetuating the whitewashed public perception. He ultimately argues that "Perhaps the question is no longer if should we condemn Wernher von Braun. Nor is it if we should venerate Wernher von Braun. Perhaps the question is whether we can forgive him. I believe we can" (286).

Another historical exploration involves a lengthy discussion of the important role artist Chesley Bonestall played in shaping the public's unrealistic imagination of the lunar surface. Cokinos argues that Bonestall's images, in concert with Jim Lovell's infamous characterization of the lunar surface as "gray and colorless" (293), played important roles in the waning public interest in the Apollo program (once NASA had successfully proved they could send humans safely to the Moon). However, as the author argues, the problem is with humanity's perception of the Moon and not the Moon itself. In his words, "We must jettison the visions of a fictional Moon... and embrace a wonder based on facts. We must fall in love with the real" (295). Excerpts from Apollo mission transcripts demonstrate exactly this, showing astronauts grappling to process and describe what they were experiencing in real time on the Moon.

Chapter 12 illuminates the shift in the scientific emphasis for the later Apollo missions and the requisite changes required in astronaut training, including hands-on practice in the desert West and Southwest where the author makes his home. The result was that the Moonwalkers "began to see places and rocks as more than objects. They saw them as stories" (314). Cokinos does an excellent job in justifying why human exploration is superior to rovers in the story of the Genesis Rock, identified as special and important by astronauts Scott and Irwin. In their own words (through mission transcript) we see the culmination of this new breed of astronaut training to recognize and understand basic geology.

Additional topics tackled in this volume include the Moon's historical role in timekeeping, superstition and folklore (including author's perhaps ill-advised attempt to recreate one of Agrippa's 16th century arcane alchemical spells, complete with cow eye and frog), the history of selenography, and hypotheses concerning the Moon's origin. Cokinos shares an amusing anecdote concerning his largely thwarted attempts to visit the birthplace of Fontenelle, author of the 1686 *Conversations on the Plurality of Worlds:* "I climbed a fence in France to trespass onto the grounds of a charming chateau" (96). Such adventures are juxtaposed with contemplative moments of observing the Moon, depictions that are deeply personal and detailed, mixing scientific and Romantic (with a capital R, as in sublime) language.

A key step in the author's journey to know the Moon was working through observing programs affiliated with the now-defunct American Lunar Society as his father neared death, and later the Royal Astronomical Society of Canada. The central theme of chapter 4, titled "Collimation," is self-explanatory to many telescope owners. The scientific and political struggles of Galileo are juxtaposed against the author's battle to get a reasonable image from his rickety childhood telescope, a 3-inch Edmund Scientific Space Conqueror reflector. Upon finding one of these instruments in a thrift store, the now adult author carefully refurbished the telescope "for the child I had been, for my father about to die, and for a scientific hero" (68).

By the end of the book, Cokinos has come to appreciate more deeply that while international treaties proclaim that the Moon belongs to no one, he prefers to think that the Moon belongs to us all. While I understand the sentiment, the claim that the Moon "belongs" to anyone reflects a Western hegemonic viewpoint that is in direct opposition to the indigenous viewpoints Cokinos takes a few moments

in this book to acknowledge. He does argue that we "need to agree on some basic tenets for treating the Moon respectfully" (377), a good first step being to protect all the current lunar "cultural heritage sites" (robotic and human landing sites; 365).

As an award-winning author, published poet, and essayist, as well as science communicator, Cokinos alternately writes in the style of an essayist, journalist, and poet, as the topics change. There are also moments of subtle humor, for example, in describing the lunar dome Mons Rümker as looking "like it sounds: a long phlegmatic throat-clearing" (174). While the work is exquisitely researched, its journalistic style (without formal citations) occasionally leads to moments of frustration, despite the selected bibliography at the end and the author's offer to share his references upon request.

Cokinos eventually becomes a self-described "lunar acolyte devoting long hours at the eyepiece... I looked to learn – to experience," arguing that "To write the Moon without seeing the Moon... would be like writing about birds without watching them fly, perch, and sing" (xxi). *Still as Bright* is ultimately a story of self-education, of passion and curiosity turned into action and observation. It is also a love story (seen in Cokinos' breathless descriptions of the thrill of the chase for particularly elusive objects, like a suitor in a Victorian novel) and a story of the scientific process. The reader comes to share his realization that in observing the Moon, we are *"exploring another world"* (emphasis original; 149).

The ultimate lesson of this book is that we should all take the time to return to our "newbie" days every once in a while, and take the opportunity to reset and reboot. In doing so, we will hopefully reclaim that sense of wonder that got us hooked on observing in the first place, those heady days of enthusiastic exploration when one can't see Messier objects, planetary nebulae, sunspots, or planets quickly enough.

It is therefore fitting that the Astronomical League has a suite of observing programs to get you started on your own personal exploration of our nearest neighbor: Lunar, Lunar II, and Lunar Evolution *(www.astroleague.org/alphabeticobserving)*. This book should help motivate you to begin that very personal journey. ✶

Kristine Larsen is a member of the Springfield Telescope Makers, and is the editor of this magazine.

LIGHT REFLECTION AND THE OBSERVER

Peter D. Geldart

Our pervasive condition is to be immersed in radiation, but what we see is constrained to the visual spectrum, to a sensitivity of about a tenth of a second, and by our position. These constraints provide a framework in which we can understand and navigate the world. The author considers moonlight on water to show that our position is crucial: when we move, bright specular reflections follow us on top of the diffuse background.

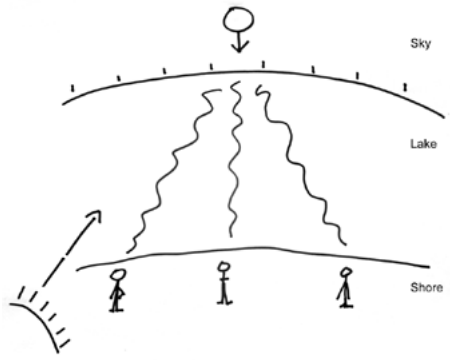
I am not overly concerned with microphysics or psychology, but with my embeddedness in the physical world: I am aware of my surroundings through moments strung together in a continuum which I comprehend based on experience, intuition, and reason. As I move, my perspective changes, altering my view of bright or shadowed surfaces, and the overlapping of objects.

Our surroundings are in an extensive mix of radiation involving the interaction of trillions of photons and electrons, and I am able to see discrete edges and complex movements at various speeds and distances, not to mention subtle hues and textures, as well as (with instruments) details on the Moon and distant astronomical phenomena.

It is predominately only visible light (about 400–700 nm), and some longer infrared, microwave, and radio wavelengths that penetrate our atmosphere. Our eyes have evolved to make use of the so-called visual spectrum because it is just sufficient for survival purposes. See *hyperphysics.phy-astr.gsu.edu/hbase/ems1.html*. The term photon, or for that matter electron, is a convenience given its well-known quantum-mechanical wave-particle duality. I will use the example of moonlight on water to consider both the physics of light reflection in nature and the importance of the observer's position.

WHAT IS REFLECTION?

Our natural environment is almost entirely illuminated by reflected sunlight, although



the word "reflected" is simplistic. We see the result of trillions of interactions between photons and electrons. This is the domain of quantum electrodynamics (QED), "the theory that describes the interactions of photons with charged particles, particularly electrons" (Stetz 2007, 5). According to Feynman (1963a; 1963b; 1979) and others in the field, light waves impact a surface and impart energy to the electrons of the material causing them to "jiggle about" and emit new photons.

More specifically, Feynman (1963a) noted "A beam of radiation falls on an atom and causes the charges (electrons) in the atom to move. The moving electrons in turn radiate in various directions," and "The quantum behavior of atomic objects (electrons, protons, neutrons, photons, and so on) is the same for all, they are all 'particle waves'" (1963b).

One could say that the light impacting an atom prompts an electron to move up to a higher orbit around the nucleus. The atom is now unstable, and at a random moment the electron will emit a photon while descending to a lower orbit (Polkinghorne 2002). This is a description based on a "planetary" model developed early in the 20th century by physicists Rutherford and Bohr. The models that have since emerged, however, consider electrons to exist in a cloud of probability around the nucleus of an atom in which their positions are indeterminate, "...like bees buzzing around a hive, but moving too rapidly to see distinctly" (Ball 2004, 78).

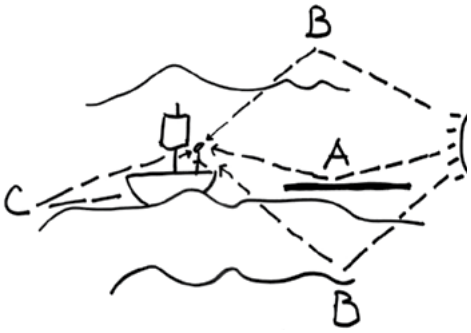
DIFFUSE VS. SPECULAR

In natural environments we experience mostly diffuse reflection, showing colors and subtle shadings that are all around us; occasionally, we see white specular reflection: sunlight or moonlight sparkling on water or the glint off a spiderweb or a smooth rock. In Anthropocene times there are numerous examples of specular reflection from artificial objects both indoors and outdoors.

The angle of reflection of the light must equal the angle of incidence if there is no change in the refractive index of the medium though which it travels. Here I am on a small

boat on a lake looking towards the low Sun.

I see a line of sparkling water towards the Sun; those arrays of atoms must be more or less horizontal from my point of view. I will also see the occasional flicker to my sides and sometimes behind me from atoms that momentarily send rays to my eyes.



Where one person sees a sparkling line, another (let's say 100 meters to the side) sees "normal" diffuse blue-green water in that area. The point is that the observer is impelled to see a specular reflection in a line on the water reaching from them to the light source.

CONCLUSION

I've discussed some aspects of the physics of light reflection and found that light does not "bounce" off objects but is absorbed by the atoms of the material, and new light is emitted. My position is crucial: specular reflection aligns to the source and moves with me on top of the diffuse background. Both specular and diffuse reflections are seen from the same atoms at the same time by separated observers. There is no "fixed" background of radiation, only a fixed physical world of objects, surfaces, water and atmosphere. I am reminded of Newton's pebbles, an allegory that proclaims there will always be more to know[1].

The example of light on water in this essay suggests that each of us is in an optical and psychological bubble which, through experience, we have learned to live with, and with great dexterity perceive our moving surroundings and far-off vistas. The enabling factor is that we only see slivers of light from moment to moment. ✶

Peter Geldart is a member of the RASC.

Notes

[1] Newton famously said "I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me" ("Isaac Newton").

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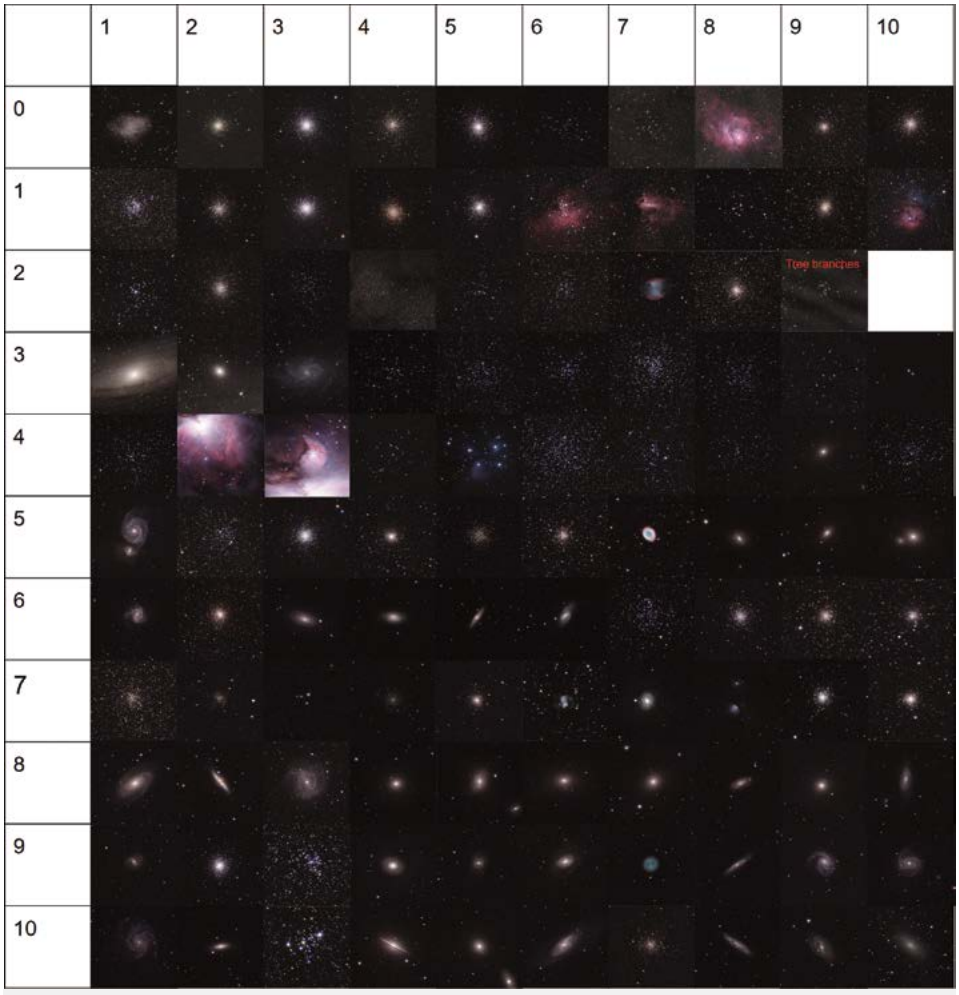
Running a Marathon in the Footsteps of Messier

By Andrew Yu

In the late 1700s, astronomer Charles Messier of Paris was hunting down new comets, but he kept running into false positives – objects that looked suspiciously like comets in his telescope, but were actually galaxies, nebulae, or star clusters. In order to quickly eliminate these objects when he discovered a potential comet, Messier compiled a list of 103 deep-sky objects that had thrown him off at one point or another. Today, however, Messier's "junk list," now extended by amateur astronomers to 110 objects, isn't used by comet hunters, but is instead an extremely popular catalogue of bright deep-sky objects which are easily observable from the northern hemsphere.

As the Messier catalogue is known so well by amateur astronomers, many have thought to observe as much of the list in one night as possible – or, for some particularly ambitious astronomers, the entire list. As luck would have it, this is indeed possible, but only at a specific time of year. Within about a week on either side of the vernal equinox (March 20 or 21), it is possible to observe all 110 Messier objects in a single dark, moonless night, as the Sun is far enough away from all 110 objects around this time. As such, the concept of a "Messier Marathon" was born, and the first such event took place in the early 1980s (Machholz 2017). Popularity of Messier Marathons has since increased, and they are now annual gatherings for many astronomical organizations.

Kneeling to set my rig up at the dark site.
Image from Texas Astronomical Society of Dallas Facebook page

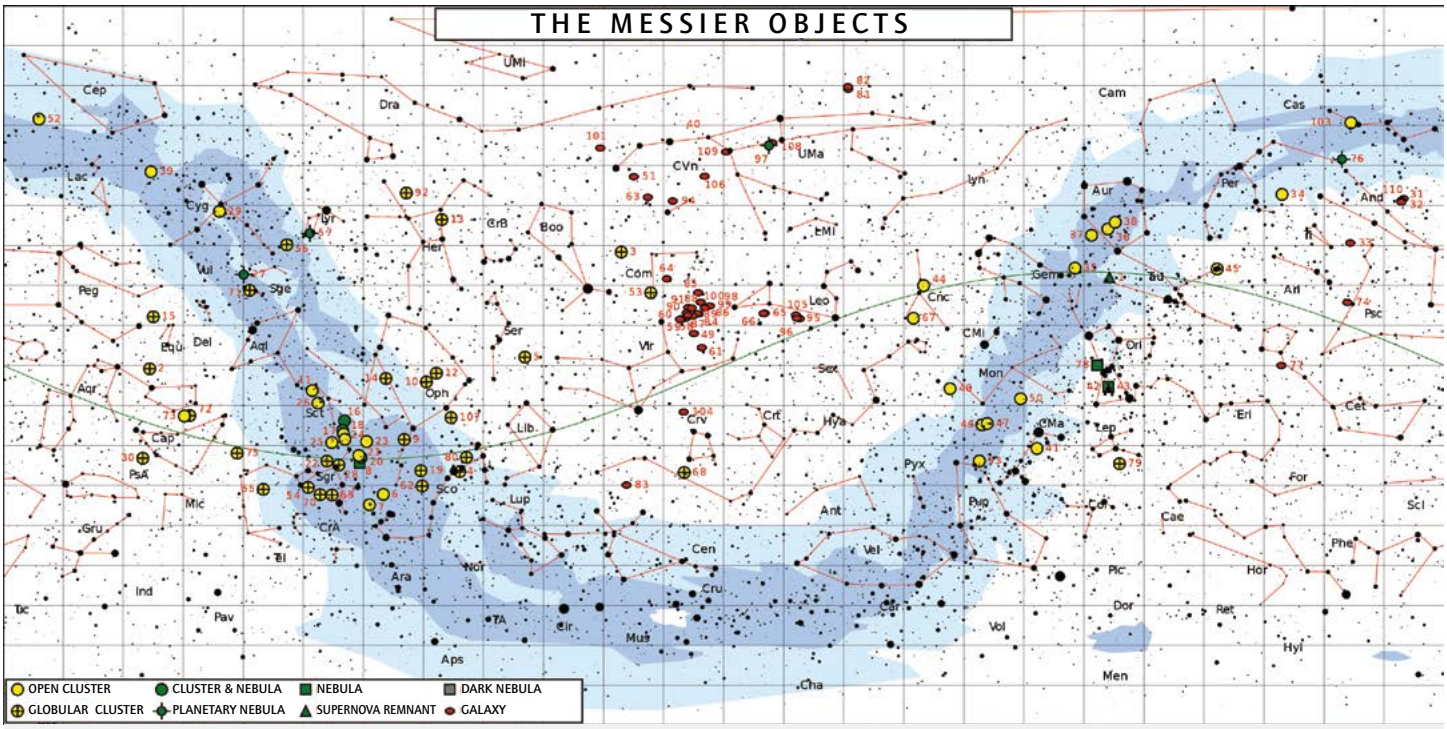


Finished photograph grid of 109/110 objects, by Andrew Yu

As a 17-year-old astronomy enthusiast in high school, I had recently grown on the idea of conducting a Messier Marathon. This year, the best night for a Messier Marathon was March 9, and my astronomy club, the Texas Astronomical Society of Dallas, was hosting the marathon at the club's dark site, about a two-hour drive from home. Being a passionate visual observer and astrophotographer, I had previously endured many late nights past midnight, and knew the sky well enough to find a majority of the Messier objects quickly on my own. However, I thought it would be more fun and fulfilling to conduct an astrophotographic marathon – instead of trying to observe each object, I would try to image each one.

The day before, I spent a few hours creating a list of the objects and sequencing it into the automated computer software which runs my astrophotography. 110 objects are a lot to cover in a night, especially when most quality astrophotographs take many hours to complete. I only allotted 3–5 minutes for each object, so I was concerned that this short exposure time would not be sufficient to capture all the objects, but it turned out to be plenty.

The next day at sunset, I rushed to set up



Star Chart of all Messier Objects by Jim Cornmell. For a larger printable copy and license information see commons.wikimedia.org/wiki/File:MessierStarChart.svg.

my rig, polar aligning and running guiding calibration. My favorite part about twilight is watching the stars appear one by one, like a curtain slowly being drawn away. Sirius, the Dog Star, was the first to appear, reminding me about the brilliant winter evening sky which would light up the evening. The remaining stars appeared in descending order of brightness, and when I could see the very faint band of the winter Milky Way, I knew it was time to start my exposures.

I wasn't too concerned about the early objects, as M74 and M33, the notorious early low-surface-brightness galaxies, were both easily revealed by my camera. As the evening progressed, I moved into a tent with a friend, who was also working on a photographic marathon like myself. Despite the air temperature slowly lowering – the low for the night was forecasted to be a chilly 37 degrees – the tent would remain nice and toasty throughout the night due to body heat.

By 10 p.m., we were finishing up with the winter star clusters in Auriga, Cancer, and Puppis, and some people were starting to drop out. It was starting to get cold, even inside the tent. I put on my thickest jacket, used only for late winter nights like this, and my wool socks. Thankfully, the sky remained crystal clear, and it was one of our most transparent nights in a while. My friend noticed that condensation was beginning to form on the roof of the tent. We were breathing out moist air, which was rising and cooling when it hit the roof. He was concerned that it would start raining inside the tent, but thankfully that never happened.

A couple of hours later, now past midnight, we were winding down on the last few spring galaxies, having just passed the 14-object craze that is the Virgo Cluster. The canonical Messier Marathon break, a relatively free hour between those galaxies and the summer Milky Way, was almost upon us, and we elected to spend it warming up inside a heated storage room, munching some Doritos. This happened to be the night when Daylight Saving Time started, and at 2 a.m. we watched the clock on my phone change from 1:59 to 3:00, with the hour hand teleporting instantly.

But soon enough, we were back in business. Scorpius and Ophiuchus were starting to rise, and we were in for a frantic early morning. There were about 40 objects left to image in about three hours before sunrise, and I let my plan quickly run through the globulars and open clusters of the Milky Way. While our cameras were exposing, we took routine looks outside towards the south to catch the magnificent Milky Way center rise, the first time I had seen it since last autumn. The roof of the tent was now starting to ice over, even though the temperature wasn't below freezing. My feet were numb, but I mostly managed to stay warm, and until about 5:30 a.m., I wasn't even that tired. Stargazing fields have to be infused with some version of Red Bull, since I seem to be able to stay awake star watching for many more hours than I would be able to stay up back home.

The last few objects, M2, M72, and M73, were quite hurried, and we just barely managed to bag them before sunrise. There was one more object, M30, which I didn't put on my plan since I knew it would be far too difficult: the Sun would be only 10 degrees below the horizon before it even rose. As the last frame of M73 finished, I noticed the eastern sky already brightening, and we threw in the towel.

I managed to sleep about 2 hours, and in the morning we didn't even bother eating breakfast before packing up and leaving. I slept about an hour in the car even while the Sun was shining into my face. That was a first.

Just as expected, my final tally was 109 out of 110, only missing M30. Even though the event threw off my sleep schedule for most of the next week, it was still a blast of a night. Perhaps next time I can bring some more friends along to experience this frenzied but fun event. ✶

Andrew Yu is founder and vice president of outreach and membership, Teen Texas Astronomical Society of Dallas, teentas.org.

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Halton Arp and His Peculiar Galaxies

By Larry McHenry

In 1966, American astrophysicist Halton Arp published a paper, "Atlas of Peculiar Galaxies," which listed 338 interesting galaxies that didn't fit into the normal Hubble classification scheme. Arp was a professor of astronomy at the California Institute of Technology and staff observer at Palomar Observatory. His paper cataloged a series of peculiar galaxies, giving them numerical designations, using the Palomar 48-inch and 200-inch telescopes. Through his work of studying these unusual galaxies, Arp broke new ground in our understanding of the Universe, and along the way sparked a debate that challenged the basics of the Big Bang theory. Today, we're going to learn about his life and accomplishments, the redshift controversy, and how to use Arp's Atlas in observing.

HALTON C. ARP

Halton Christian Arp was born on March 21, 1927, in New York City. The son of artists, Arp grew up in the Greenwich Village area of Manhattan and spent his childhood traveling with his parents every year to Woodstock, New York, for seasonal art fairs. Arp did not attend formal public school until he was almost 10 years old, being self-taught at home by his parents and others from the local artist community (Kanipe & Webb 2006, 58). When he was older, Arp was sent to a U.S. Naval Academy prep school in Buzzards Bay, Massachusetts, where he graduated with his high school diploma; afterwards, he spent two years in the Navy before enrolling at Harvard.

After graduating from Harvard in 1949, Arp's first job as an astronomer was as a summer intern "computer" at Mount Wilson Observatory. Upon graduating from Caltech in 1953, Arp was offered a job at Mount Wilson by Edwin Hubble; Arp used the 60-inch reflector to gather the nova data that Hubble required for his distance-scale research. After Hubble passed away from a stroke in autumn 1953, the observatory kept Arp on staff for two years to finish Hubble's last project. Afterwards, Arp worked as a research assistant in South Africa, using the 24-inch Schmidt telescope at Cape Town to study Cepheid variables in the Small Magellanic Cloud.

Upon completing that work in 1957, Arp became a Fellow of the Carnegie Institution and a full staff astronomer at Palomar Observatory, working there for the next 29 years. While there, he had frequent access to the 200-inch Hale reflector to observe galaxies. Arp was considered a master of astronomical photographic techniques with the 200-inch telescope (Shields).

In 1983, Arp retired from Caltech and joined the staff of the Max Planck Institute for Astrophysics near Munich, Germany, where he continued his research.

ARP'S REDSHIFT CONTROVERSY

While at Palomar during the early 1960s, Arp began collecting unusual galaxies that other researchers dropped from their studies as too unusual or strange. Using his "artist's eye" (Ferris 1977, 193), Arp realized that these odd, peculiar galaxies represented different stages in galactic evolution, and devoted his career to studying them using the 200-inch Hale telescope. His goal was to produce a catalog that other cosmologists could use to model and test the Hubble theory of galaxy formation.

Arp noticed that some of his elliptical galaxies associated with disturbed spirals seemed to have relationships with nearby quasi-stellar objects (QSOs), or quasar radio sources, which in the mid-1960s had recently been discovered to have high redshifts, indicating great distances and extreme age. Quasars were generally considered to be leftovers from the creation of the early Universe. But Arp's observational evidence from the 200-inch Hale telescope suggested that some high-velocity quasars were physically connected to other galaxies with much lower redshifts. This seemed impossible! Arp coined a new phrase to describe what he was seeing: discordant redshift (Ferris 1977, 196). He came to believe that an object's redshift may not be solely explained by its distance and velocity, and there may be some other cosmological mechanism at work. This eventually led to his challenge to the Big Bang theory and the assumption that the Universe

is expanding. Arp and a few other prominent astronomers of the day led a small band of challengers in a long-running dissent from the views of most of the traditional astronomical world that supports the Big Bang cosmology.

A few of Arp's discordant redshift objects are NGC 7603 (Arp 92) in Pisces and NGC 4319 and Markarian 205 in Draco. NGC 7603 is a Seyfert-type spiral galaxy with an active galactic nucleus and a redshift of z=0.029. It has a small elliptical companion at the end of one arm with double the redshift of the parent galaxy, z=0.057. Additionally, several small knots of material along the arm connecting with the elliptical have very high redshifts, z=0.243 and z=0.391. Arp believed that all three high-redshift objects had been ejected from the core of NGC 7603, with the elliptical being the oldest and furthest object with its redshift having slowed. Most other astronomers determined that this is just a chance alignment between NGC 7603's spiral arms and a more distant elliptical galaxy and several cosmologically distant quasars (Kanipe & Webb 2006, 86).

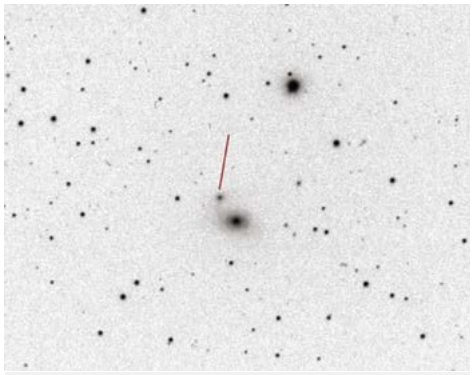
NGC 4319 is a typical barred spiral galaxy with spiral arms emerging from an internal bar structure. It has a redshift of z=0.0046, making it relatively nearby cosmologically. Markarian 205 is a low-luminosity active quasar at a redshift of z=0.071, making it about 15 times more distant than NGC 4319. A very faint filament bridge connecting these two objects makes them peculiar. This connection should not be possible, given the difference in redshifts. Arp believed this to be a true connection, as Markarian 205 must have been ejected by NGC 4319 and is trailing material. But the conclusion of the majority of astronomers is that this bridge is just an irregularity in the spiral arm structure of NGC 4319 and a chance alignment or optical illusion of material projected in front of Markarian 205 (Kanipe & Webb 2006, 82).

OBSERVING ARP'S PECULIAR GALAXIES

So, where can you find Arp's peculiar galaxies? Galaxies in general can be found away from the glowing band of light that we call the Milky Way, our home galaxy. Usually, when we want to observe bright or dark nebulae and star clusters, the Milky Way is exactly where we want to look, but for galaxies, this is the "Zone of Avoidance" (Jones 1981, 23), as all the gas, dust, nebulae, and stars of the spiral arms of our galaxy tend to obscure all the faint extra-galactic "nebulae" that we want to observe.

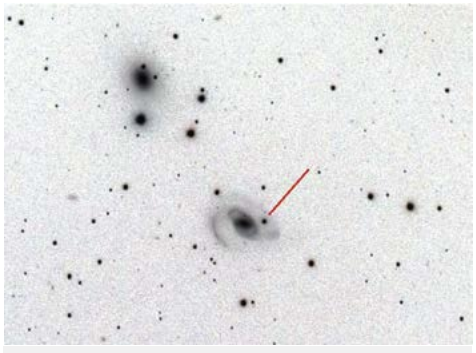
Arp 319 - NGC 7317, 7318A, 7318B, 7319, 7320 (Stephan's Quintet) *8-inch SCT f/6.3 with ZWO ASI294MC and L-Pro broadband filter, 10-minute exposure, EAA livestacked for 1 hour)*

Peculiar galaxies come in all shapes, sizes, and brightness. Some large, bright galaxies are best suited for medium-size telescopes, while others are very faint and require large apertures. A number of



Arp 92 - NGC 7603 *8-inch SCT f/6.3 with ZWO ASI294MC and L-Pro broadband filter, 3-minute exposure, EAA livestacked for 30 minutes*

Messier objects are also Arp galaxies, and observing these is a good way to get started, even using 8- to 10-inch telescopes. These include M51 (Arp 85), M77 (Arp 37), M82 (Arp 337), and M101 (Arp 26). Some galaxies are fairly easy to find from suburban locations, but most galaxies require observing from a dark-sky country location.



NGC 4319 & Markarian 205 *8-inch SCT f/6.3 with ZWO ASI294MC and L-Pro broadband filter, 3-minute exposure, EAA livestacked for 30 minutes*

A photographic atlas or picture of the galaxies will help you locate and identify the objects and frame your astrophotography image. You can download a PDF copy of Arp's original atlas to your computer, tablet, or smart phone. The catalog is organized into five main areas or classes, each having many sub-classifications. There are 338 galaxies with some form of abnormality,

Arp 337 – M82 *8-inch SCT f/6.3 with ZWO ASI294MC and L-Pro broadband filter, 3-minute exposure, EAA livestacked for 30 minutes*

irregularity, or odd feature such as unusual arms with detached segments, fragments, or ejected material; filaments; rings; tails; jets; loops; bridges; or with faint companion galaxies aligned in a chain or connected to or disturbing close spirals. You'll need all your visual observing skills to find and bring out the subtle details in these objects. Many of

Arp 85 - M51 *8-inch SCT f/6.3 with (ZWO ASI294MC and L-Pro broadband filter, 5-minute exposure, EAA livestacked for 1 hour*

Arp's features are very faint, and depending on the size of the telescope you are using, may not be visible. But like any deep-sky object, half the fun is just successfully finding it and knowing what you are observing.

ARP'S LEGACY AND CONCLUSION

Until his death at the age of 86 on December 28, 2013, in Munich, Germany, Arp continued to hold his contrary view of the Big Bang and published his research in

popular and scientific literature. Today, with modern observatories and space telescopes, conclusive research has disproven Arp's counter-theories of intrinsic redshift (Arp 1998, 9). Even though he was eventually proven wrong, Halton Arp made significant contributions to astrophysics by his strong challenges to accepted theory, based on observations, forcing other astronomers to revalidate their assumptions about galaxy formation and cosmology.

Halton C. Arp's "Atlas of Peculiar Galaxies" is not just a neat list of interesting-looking galaxies, but also a useful tool for advanced amateur astronomers looking for deep-sky observing or imaging projects. Professionally, Arp's atlas is recognized as an excellent compilation of interacting and merging galaxies that provides a useful benchmark of peculiar galaxies to compare against more distant objects that are continually being discovered.

Arp is considered by some to be one of the great American observational astronomers of the latter half of the 20th century, living at the dawn of the age of the quasar, which led to a deeper understanding of our expanding universe. His willingness to follow observational data wherever it led, even if it didn't fit accepted theory, is a hallmark of the scientific method. Arp's work lives on today, both for the professional astrophysicist and amateur astronomer alike.

I encourage everyone to get out tonight and try your hand at finding and observing these strange and elusive deep-sky objects, the peculiar galaxies of Halton C. Arp. ✶

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

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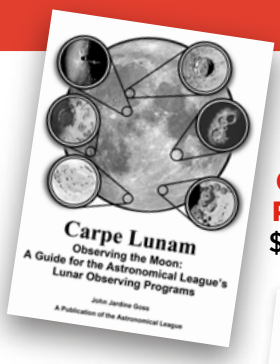

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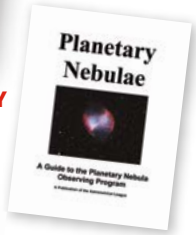

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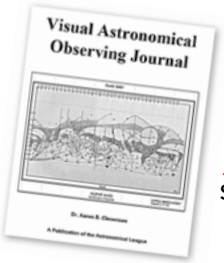

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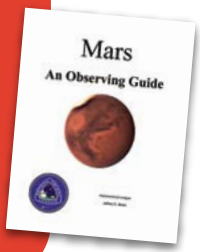

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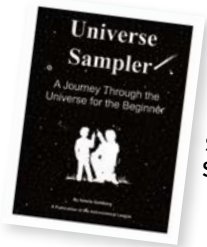

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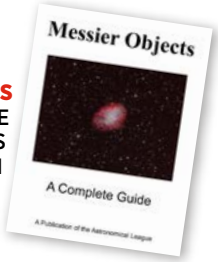

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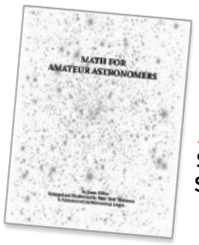

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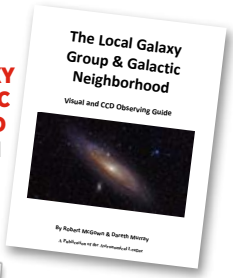

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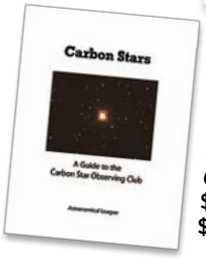

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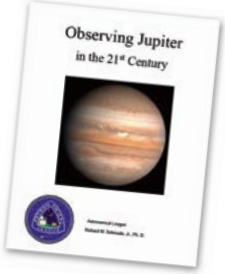

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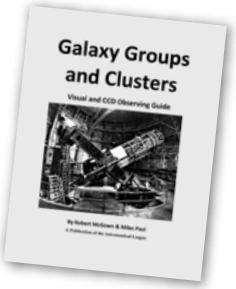

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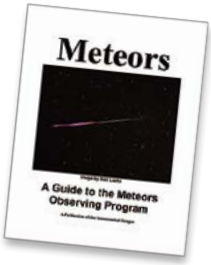

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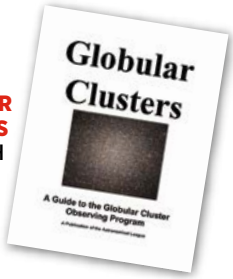

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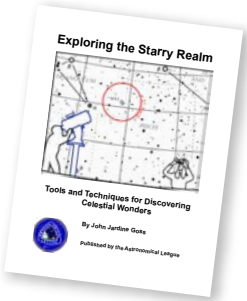

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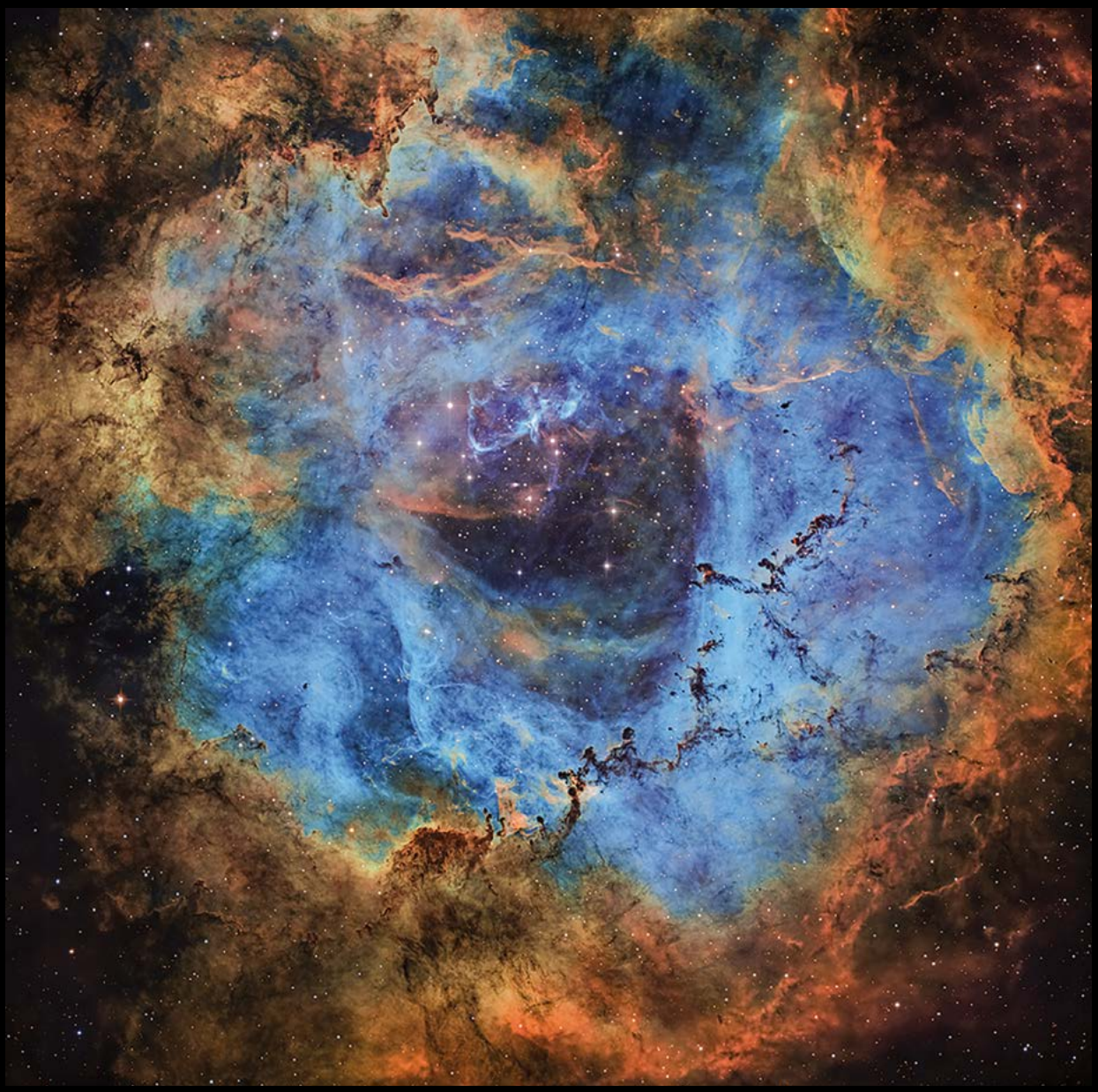

ABOVE: Bernard Miller (East Valley Astronomy Club) captured this four panel mosaic image of the Rosette Nebula (NGC 2244) with a PlaneWave 17-inch CDK with a FLI 16803 CCD camera from his observatory in Animas, New Mexico

NEXT PAGE TOP: John Richards (Middle Georgia Astronomical Society) captured this image of Sharpless 274 – The Medusa Nebula – using a ZWO FF107 APO Refractor with a ZWO ASI 294MM Pro camera from his observatory in Warner Robins, Georgia.

NEXT PAGE BOTTOM: M.J. Post (Longmont Astronomical Society) captured this image of Abell 426 using a PlaneWave CDK14 and a ZWO ASI 6200MC camera from his Dark Sky New Mexico observatory in Animas, New Mexico.

Gallery

Jeff Kisslinger (Saint Louis Astronomical Society) captured this fantastic image of NGC 6820 using a Celestron Edge HD 11 with HyperStar and a ZWO ASI2600MM camera from Saint Louis.

COMING NEXT ISSUE: YOUR ECLIPSE PHOTOS

Send your best images to *photoeditor@astroleague.org* by July 1 for a chance to show them off in *Reflector!*

This image was captured by Joseph Giammarco at Killeen, Texas.

OBSERVING AWARDS

2023 ANNULAR SOLAR ECLIPSE OBSERVING CHALLENGE

Doug Lively, Silver, Raleigh Astronomy Club; **Brittney Miller,** Silver, Atlanta Astronomy Club; **Amy Northrop,** Silver, Baton Rouge Astronomical Society; **Jim Tomney,** Silver, Howard Astronomical League

ADVANCED BINOCULAR DOUBLE STAR OBSERVING PROGRAM

No. 60, **Andrew Jaffe,** New Hampshire Astronomical Society; No. 61, **Pete Hermes,** Tucson Amateur Astronomy Association; No. 62, **Richard Wheeler,** Northeast Florida Astronomical Society

ALTERNATE CONSTELLATION OBSERVING PROGRAM

No. 18, **Paul Harrington,** Silver, Member-at-Large

ANALEMMA OBSERVING PROGRAM

No. 23, **Debra Wagner,** Member-at-Large

ARP PECULIAR GALAXIES NORTHERN OBSERVING PROGRAM

No. 120-I, **Gregg Ruppel,** Tucson Amateur Astronomy Association; No. 121, **Alan Scott,** The Albuquerque Astronomical Society

ARP PECULIAR GALAXIES SOUTHERN OBSERVING PROGRAM

No. 23, **Paul Harrington,** Member-at-Large; No. 24, **Viola Sanchez,** The Albuquerque Astronomical Society

ASTERISM OBSERVING PROGRAM

No. 79, **Viola Sanchez,** The Albuquerque Astronomical Society

ASTEROID OBSERVING PROGRAM

No. 74, **Michael Bond,** Regular, Northern Virginia Astronomy Club; No. 78, **David Roemer,** Gold, Huachuca Astronomy Club; No. 79, **John T. Grage,** Gold, Member-at-Large

ASTRONOMY BEFORE THE TELESCOPE OBSERVING CERTIFICATE

No. 3, **Brian Chopp,** Neville Public Museum Astronomical Society; No. 4, **Madeline Chopp,** Neville Public Museum Astronomical Society

BEYOND POLARIS OBSERVING PROGRAM

No. 71, **Marty Rossiter,** Member-at-Large; No. 72, **Carolyn Jett,** Astronomical Society of Kansas City

BINOCULAR DOUBLE STAR OBSERVING PROGRAM

No. 209, **Robert Abraham,** Shreveport/Bossier Astronomical Society; No. 210, **John W. Bierman,** Miami Valley Astronomical Society; No. 211, **Joe Fazio,** Cumberland Astronomy Club; No. 212, **DeWayne Carver,** Tallahassee Astronomical Society

BINOCULAR MESSIER OBSERVING PROGRAM

No. 1261, **Michael R. Martin,** Roanoke Valley Astronomical Society; No. 1262, **Joe Fazio,** Cumberland Astronomy Club

BINOCULAR VARIABLE STAR OBSERVING PROGRAM

No. 66, **Michael Rapp,** Houston Astronomical Society; No. 67, **Steve Riegel,** Colorado Springs Astronomical Society

CALDWELL OBSERVING PROGRAM

No. 33, **Dee Friesen,** Gold, The Albuquerque Astronomical Society; No. 295-I, **Thomas V. Schumann,** Silver, Lifetime Member; No. 296, **Kim Balliett,** Silver, Richland Astronomical Society; No. 297, **Dee Friesen,** Silver, The Albuquerque Astronomical Society; No. 298, **Tim Moyer,** South Jersey Astronomy Club

CARBON STAR OBSERVING PROGRAM

No. 158, **James R. Brunkella,** Ventura County Astronomical Society; No. 159, **Scott Donnell,** Colorado Springs Astronomical Society

CITIZEN SCIENCE AWARD

Dan Crowson, Astronomical Society of Eastern Missouri, Active Asteroids, Active, Gold Class 50; **Dan Crowson,** Astronomical Society of Eastern Missouri, Int'l Astro. Search Collab., Active, Gold Class 6; **Mark Ellison,** Member-at-Large, Observational, Variable Stars, Silver; **Al Lamperti,** Delaware Valley Amateur Astronomers, Active Asteroids, Active, Gold Class 231; **Al Lamperti,** Delaware Valley Amateur Astronomers, Star Notes, Active, Gold Class 409; **Al Lamperti,** Delaware Valley Amateur Astronomers, Cloud Spotting on Mars, Active, Gold Class 4; **Brad Young,** Astronomy Club of Tulsa, Variable Stars, Observational, Gold Class 12;

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DOUBLE STAR OBSERVING PROGRAM

No. 711, **Brian McGuinness,** Northern Colorado Astronomical Society

GALAXY GROUPS AND CLUSTERS OBSERVING PROGRAM

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GALILEO OBSERVING PROGRAM

No. 93, **Carolyn Mirich,** member-at-large; No. 94-B, **Jean Napp,** Iowa County Astronomers

GLOBULAR CLUSTER OBSERVING PROGRAM

No. 400-I, **Tom Nathe,** Rose City Astronomers; No. 401, **David Hiegel,** Central Arkansas Astronomical Society; No. 402, **Al Hamrick,** Raleigh Astronomy Club

HERSCHEL 400 OBSERVING PROGRAM

No. 661, **Michael Blase,** Olympic Astronomical Society; No. 662, **Andrew Wolfe,** Member-at-Large

HERSCHEL 400 (SOUTHERN) OBSERVING PROGRAM

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JUPITER OBSERVING PROGRAM

No. 6, **Jim Tomney,** Howard Astronomical League

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No. 35, **Karl Schultz,** Central Arkansas Astronomical Society; No. 36-I, **Ryan Behrends,** Hill Country Astronomers

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