

Published by the Astronomical League
Vol. 78, No. 3 JUNE 2026

Reflector



A NEW VIEW OF STELLAFANE
AMATEUR ASTRONOMICAL SPECTROSCOPY
MUTUAL EVENTS OF GALILEAN SATELLITES
OBSERVING THE MOON
THE HIDDEN COST OF LIGHT POLLUTION
ON WILDLIFE
MY JOURNEY FROM VISUAL OBSERVING
TO ASTROPHOTOGRAPHY

...AND MORE

SHOP OUR STORE

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

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

PLANETARY NEBULAE
\$19 PLUS \$7 S&H

ASTRONOMICAL LEAGUE VISUAL ASTRONOMICAL OBSERVING JOURNAL
\$18 PLUS \$7 S&H

ASTRONOMICAL LEAGUE ASTRONOMICAL IMAGING JOURNAL
\$18 PLUS \$7 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 LAPEL PIN
(ONE-INCH DIAMETER) \$6 PLUS \$3 S&H

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

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

A PATHWAY TO THE STARS
THIS MANUAL IS A GREAT INTRODUCTION TO ASTRONOMY FOR THE NEW ASTRONOMER.
\$12 PLUS \$5 S&H

UNIVERSE SAMPLER
A JOURNEY THROUGH THE UNIVERSE FOR THE BEGINNER
\$14 PLUS \$6 S&H

MESSIER OBJECTS
A COMPLETE GUIDE
\$16 PLUS \$6 S&H

MATH FOR AMATEUR ASTRONOMERS
\$15 PLUS \$6 S&H

THE LOCAL GALAXY GROUP & GALACTIC NEIGHBORHOOD
\$24 PLUS \$8 S&H

CARBON STARS
A GUIDE TO THE CARBON STAR OBSERVING CLUB
\$12 PLUS \$5 S&H

OBSERVING JUPITER IN THE 21ST CENTURY
\$14 PLUS \$6 S&H

THE HERSCHEL II OBSERVING PROGRAM
\$20, PLUS \$7 S&H

GALAXY GROUPS AND CLUSTERS
\$26 PLUS \$8 S&H

METEORS—A GUIDE TO THE METEORS OBSERVING PROGRAM
\$12 PLUS \$5 S&H

GLOBULAR CLUSTERS
\$16 PLUS \$6 S&H

EXPLORING THE STARRY REALM
TOOLS AND TECHNIQUES FOR DISCOVERING CELESTIAL WONDERS
\$15 PLUS \$6 S&H

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

ASTRONOMICAL LEAGUE CLOTH PATCH
(3" DIAMETER) FULL COLOR \$7 PLUS \$1.50 S&H
BLUE & WHITE \$6 PLUS \$1.50 S&H

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

Reflector
A NEW VIEW OF STELLARAE
AMATEUR ASTRONOMICAL SPECTROSCOPY
MUTUAL EVENTS OF GALILEAN SATELLITES
THE HIDDEN COST OF LIGHT POLLUTION
BY JIMMY J. JAMES
A GUIDE TO 400 DEEP-SKY OBJECTS
A PUBLICATION OF THE ASTRONOMICAL LEAGUE

David Stearn (Tucson Amateur Astronomy Association) captured this image of IC 2118 - The Witch Head Nebula from his backyard in Vail, Arizona with an Askar SQA55 and a ZWO ASI2600MC Pro camera.

The Astronomical League Magazine
Vol. 78, No. 3 • ISSN: 0034-2963 • JUNE 2026

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

Contents

4.....President's Column

5.....Election Bios

5.....Meet our editor Susan Rambo

6.....DarkSky Corner

6.....Full STEAM Ahead

6.....Deep-Sky Objects

7.....Upcoming Film Will Give a New View of Stellafane

8.....Amateur Astronomical Spectroscopy and Its Value in Scientific Research

12.....Mutual Events of Galilean Satellites

14.....Observing the Moon

15.....2025 Ecology Review: The Hidden Cost of Light Pollution on Wildlife

16.....From Eyepiece to Image: My Journey from Visual Observing to Astrophotography

19.....Largest Image of Its Kind Shows Hidden Chemistry at the Heart of the Milky Way

20.....Observing Awards

24.....Gallery

LIBRARY TELESCOPE PROGRAM!

Donate a quality telescope to your local library for patrons to check out as they do books!

The preferred telescope is a 4.5 inch Dob manufactured for this purpose through **High Point Scientific**.

- easy to use
- very portable and light weight
- a sturdy alt-az mount
- quality optics

Perfect for Club Outreach!

<https://www.librarytelescope.org>

"This handy pocket guide provides the reader with a lifetime list of great objects to observe."

"Every observer needs a good star atlas. But charts alone aren't of much value in helping you decide what objects of the thousands plotted are worth looking at. **Objects in the Heavens** provides that essential guide."

- Alan Dyer

Available only from
BirrenDesign.com/astro.html
606-340-0023

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	December 1
June issue	March 1
September issue	June 1
December issue	September 1

Written and graphic material from this publication may be reprinted only for non-profit benefit of interested parties, provided specific credit is given to the writer(s), *Reflector*, and the Astronomical League. Any other use of material, including graphics and photographs, is subject to express permission from the Editor and the Astronomical League.

NATIONAL OFFICERS

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

Vice President
Terry Mann
9201 Ward Parkway, Suite 100, Kansas City, MO 64114 • vicepresident@astroleague.org

Secretary
Aaron Clevenson
19411 Cluster Oaks Dr., Humble, TX 77346-2918
281-852-4667 • secretary@astroleague.org

Treasurer
Mike Coucke
16901 SE Lee Blvd., Lawton, OK 73501
580-291-8392 • treasurer@astroleague.org

Executive Secretary
Lucia Harcum
1224 Cliffview Road, Waco, TX 76710
254-772-3738 • executivesecretary@astroleague.org

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

National Observing Program Directors
Cliff Mygatt, Lead
cliffandchris@wavecable.com
Al Lamperti
lamperti@temple.edu
Marie Lott
Lott.Marie@gmail.com
Aaron B. Clevenson, Liason
aaron@clevenson.org
Maynard Pittendreigh
maynard@pittendreigh.net
Michael Hotka
mhotka@yahoo.com

Astronomical League Historian
Denise Moser • historian@astroleague.org

LETTERS TO THE EDITOR

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

REFLECTOR STAFF

Managing Editor Kristine Larsen larsen@ccsu.edu	Advertising Representative Joe Faulkner advertising@astroleague.org
---	---

Assistant Editor
Susan Rambo
susan.rambo@comcast.net

Photo Editor
Dan Crowson
photoeditor@astroleague.org

Design/Production
Max Nomad
maxnomad68@gmail.com
Christopher Klein
chris_klein@me.com



President's Column

PRESIDENT'S COLUMN

Observing Program News. I want to begin by thanking Aaron Clevenson who recently stepped down as the lead national director of our amazing Observing Program Division (OPD) after some 16 years of service. As League secretary, he will continue to serve as a liaison between the League's Executive Committee and the Division. Aaron and John Martin are also heavily involved in leading a new web team that seeks to keep our website running smoothly with corrections, resolution of security issues, and updated awards and club information. It's a terribly difficult job, and Aaron and John continue to put in a lot of work by leading, and adding qualified members to, that team.

I also want to congratulate Cliff Mygatt for taking over Aaron's role as lead national director and Mike Hotka for accepting his new role as a national director of the Division. Running the OPD is a difficult job requiring constant review and adjustment of rules, adaptation of programs to new observing techniques, review and approval of new programs, budgeting of program costs and supplies, interviewing of program coordinator candidates, resolution of questions, updates to the awards database, and assistance to the 35 or so volunteers who coordinate our nearly

80 observing regimens and master observer certifications.

ALCon '26. Don't forget that we have an amazing national convention coming up on August 12–15 hosted by the Cincinnati Astronomical Society (CAS). The event features a beautiful riverfront hotel, a gala banquet, featured speakers, a Star-B-Que at the art deco museum at Union Station, available visits to the Banks entertainment districts, an underground brewery, the Newport Aquarium, and the Cincinnati Observatory, plus a special privately-sponsored afterparty on Sunday the 16th at the incredible Moeller Observatory in southern Ohio – an event open only to registered attendees. Special thanks go to convention co-chairs, Laura Zajac and Eric Chermely, CAS president Bryan Simpson, and the entire convention staff for all their work on this gathering. Registration is open. Just log onto the League website at www.astroleague.org and scroll down to the ALCon '26 logo featuring the Cincinnati skyline. Grab your hotel room before the room block fills!

ALCon '27. I also have news about the following year's convention. We have had a change-up due to venue availability, and our 2027 convention will be held, for the first time ever, in Big Sky country – in Billings, Montana! We will be hosted by the Southwest Montana Astronomical Society in Bozeman, Montana, the Yellowstone Valley Astronomical Society in Billings, Montana, the Astronomical Society of Bighorn Basin in Cody, Wyoming, and the Whistler Observatory in Red Lodge, Montana. They don't call it Big Sky country for nothing, so plan on bringing some big aperture with you! We'll have more news about that convention in the coming months. Very special thanks go to Lynn Powers and Randy Begger for undertaking the extensive organizational work needed for this event.

Let me also give a shoutout to Krista Lemoine and Lowell Lyon for their efforts in helping us locate this wonderful venue for our 2027 meeting. Venue selection is an increasingly difficult task, and the amazing opportunity they found for us in

Montana is a tribute to their skill and dedication.

Ad Manager. I want to welcome our new advertising manager, Joe Faulkner, to the *Reflector* staff. Joe holds a B.S. degree in public administration from the University of Arizona and a M.S. degree in business administration from Eastern Washington University. He also has extensive sales experience in aerospace and retail industries. Thanks for undertaking this task for us, Joe. We are lucky to have you.

New Council Member. I also want to welcome our newest council member, Anthony Bryan, who has been appointed as the new Great Lakes Region (GLR) representative. Tony just completed 9 years of service as president of the Evansville Astronomical Society and is a regular attendee, along with his wife Donna ("ALCon mom" to many of our youth award winners), at our national conventions. In December, Tony and Donna received the 2025 Hans Baldauf Award, the GLRAL's highest award for service to the region.

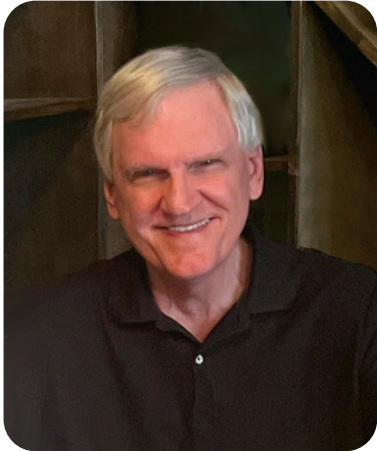
WRAL. Last, but hardly least, I want to thank Teresa Bippert-Plymate and Claude Plymate for their seminal work in re-energizing the League's Western Region. Through monthly Zoom meetings and pure initiative, the Plymates marshalled the assistance of more than a dozen club presidents, many in their home state of California, and secured meeting space at Lowell Observatory in Flagstaff, Arizona, for a regional meeting and election on April 15.

I hope to see you in Cincinnati!

—Chuck Allen, President

Election Bios

LEAGUE ELECTIONS 2026



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

Chuck Allen is the current president of the Astronomical League and a League past president

(1998–2002) and vice president (1994–98, 2020–24). In 1993, he founded the League's National Young Astronomer Award, recognizing high-school research. Chuck holds Master Observer – Gold Award status with 43 observing programs completed and nearly 12,000 astronomical observations logged. He has received the League's G. R. Wright Award for service and its Master Outreach award for giving more than 570 lectures and programs to universities, secondary schools, societies, and conventions and making more than 50 appearances in Explore Scientific's Global Star Party and AL Live broadcasts. He co-chaired ALCon '21 Virtual and is actively involved in planning ALCons through 2029.

Chuck is past president of the Louisville Astronomical Society and current program director of the Evansville Astronomical Society. He served as a judge and lead judge for the Intel (now Regeneron) International Science and Engineering Fair (1995–2002) and currently serves as a judge of best-in-fair high school for the Louisville Regional Science Fair.

Chuck graduated from Duke University and the University of Kentucky College of Law and was a partner in Kentucky's largest firm for 27 years. He is recognized in both Marquis *Who's Who in America* and his high school Hall of Fame and is a former US Air Force officer (1970–74) and published author. He has pursued astronomy since age seven and has mentored dozens of young people in their pursuit of science careers.



CANDIDATE FOR VICE PRESIDENT
TERRY MANN

Terry Mann currently serves as vice president of the Astronomical League. She has previously held multiple leadership positions within the organization, including secretary (1997–2001), vice president (2002–2006), and president (2006–2010). Additionally, Terry is chair of the Great Lakes Region (2018–present), Astronomical

League Awards chair, and acts as trustee of the Astronomical League.

Her dedication to astronomy has been recognized with several awards, including the G. R. Wright Award for service (2004) and the Hans Bauldauf Award for significant contributions to the field (2007). She co-chaired ALCon 2011 at Bryce Canyon National Park and ALCon 2021 Virtual. She is currently organizing future ALCons.

Terry programs and co-hosts the Astronomical League Live monthly broadcast, which just finished its 57th episode in March 2026. This initiative enables the League to engage with a global audience, offering accessible content to members unable to attend events.

She also coordinates with speakers from the Astronomical League for the Explore Scientific Global Star Parties. Terry, herself, is an experienced presenter, having spoken at various schools, conferences, star parties, and events.

She is committed to advancing the League's virtual programming, in-person education, and outreach initiatives to benefit clubs, members, and the public. She emphasizes the importance of providing information and support regarding the League, astronomy, and space-related events to both members and the wider community.

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

Susan Rambo



A STAR IS BORN!

The *Reflector* has a new assistant editor, replacing longtime assistant editor Kevin Jones, who retired from the magazine in December. Starting with this issue, Susan Rambo will be looking for errant commas, hyphens masquerading as em dashes, and other editing and formatting faux pas. Susan spent her career in publishing as a managing editor for technology magazines and websites, such as *Embedded Systems Programming/Design*, *Embedded.com*, *EE Times*, and *Semiconductor Engineering*.

She currently serves as the board secretary and assistant archivist of the Eastbay Astronomical Society (EAS) and participates in outreach star parties at schools and as volunteer for the Chabot Space & Science Center in Oakland, Calif. She grew up nearby in Livermore, Calif., where as a child she owned a bright-red AstroScan telescope; she was inspired to ask for it because her father made his own telescope while taking a class from John Dobson. She continues to live in the San Francisco Bay Area with her husband, Raymond Howard, who is the EAS outreach coordinator and an Astronomical League Master Observer and coordinator of two observing programs. Welcome aboard, Susan!

DarkSky Corner

There was a recent very important dark sky win in Chile. The dark skies over Northern Chile's Atacama Desert are some of the very darkest on Earth. Proyecto INNA, a large-scale industrial "green"-energy project, had been proposed near such observatory sites as the European Southern Observatory's Paranal Observatory. The early plans for the industrial project proposed a sprawling 3,000-hectare development that would have degraded the sky quality of several of the world's top observatories. It is ironic that a green-energy project would degrade the finest night skies in the world. Fundación Cielos de Chile led the fight against the project, arguing that it not only would degrade the skies for nearby world-leading observatories but also be harmful for local ecosystems, communities, and the cultural landscape across the region. Fortunately,

widespread opposition to the project caused its proposal to be withdrawn. It was a close call, and the situation still needs to be monitored. For more information see the DarkSky article at darksky.org/news/from-local-concern-to-national-awareness-how-chiles-recent-dark-sky-win-offers-a-model-for-future-efforts/.

—Tim Hunter

Full STEAM Ahead

IS THE TIDE TURNING?

I've literally just returned from the Winter Star Party (WSP), our yearly astronomy trek taken in the middle of winter. The trip out featured an interesting range of temperatures and has us anticipating a sunny future.

While running a vendor table there a conversation with one gentleman, Matthew, particularly piqued my "spidey senses." It turned out that he had just moved from my home state down to Florida and had been elected as his club's president. He continued to explain that he was 40 years old and knew of other people his age who were also now presidents of their respective clubs in his part of Florida. You can understand my interest, given the well-known "graying" of amateur astronomy.

This well-spoken man then explained how his club was not active in the Astronomical League's Observing Program nor doing much outreach. I mentioned that I had given a talk on the Observing Program at WSP and if he was interested, I would be happy to be a presenter at a future club meeting, which was met with enthusiasm.

As he continued, he revealed that the club had done such activities in the past and had simply stopped; he plans to resurrect them. For example, he had contacted a large community organization that holds local events, only to find that the club used to hold events with them in the past. The end result was that they were elated to be back working with the astronomy club once again.

But wait, there's more. There are several clubs in close proximity, and some of these are connected to the Florida college educational system; these few clubs have banded together and attend each others' events, regardless of the hosting club.

What did I take away from this serendipitous encounter? One, that astronomy is a great connector of people; second, the science of astronomy is worth supporting; and three, younger leaders have stepped up and are making great strides to bridge the gap between younger generations and their experienced elders. This is exactly how it should be.

The most interesting thing that came to mind is the communication between clubs; as a result, they want to have a meeting where they have speakers and share information with each other. Is this a proto-regional convention in the works? I talked to him about the history and regional structure of the League and saw the lightbulb go off.

I will stay connected with Matthew and provide whatever assistance I can offer while keeping my ears to the ground.

Full STEAM ahead, while preparing some B.B.Q. lighter fluid to fuel the fire...

—Peggy Walker

Broken Arrow Sidewalk Astronomers
www.facebook.com/BASideWalkAstronomer

Deep Sky Objects

A Spherical Gem in the Harp

M56 is one of two objects residing in the Constellation Lyra catalogued by Charles Messier. The other is the Ring Nebula, M57. On January 19, 1779, Messier discovered a comet in Lyra; however, the comet had already been spied by Johann Elert Bode several hours earlier. As a result, they are considered co-discoverers of Comet Bode (C/1779 A1). Bode also discovered M81 (Bode's galaxy), formulated the Titius-Bode Law, and determined the orbit of Uranus (the name of which he suggested after it was discovered by William Herschel).

Comet Bode was close to M56 the night Messier discovered the comet. However, he did



not spot M56 until January 23, 1779. The comet was close to M57 on January 24, 1779, but Messier did not discover M57 until January 31, 1779. Perhaps it was cloudy the nights between the M56 and M57 discoveries.

Using his 18.7-inch Newtonian telescope, William Herschel was the first to resolve M56's stars, thereby determining that M56 was a star cluster. M56 later became entry 6779 in the New General Catalog (NGC). Its apparent size in telescopes is only one-third the actually size of the cluster. The outer two-thirds contains stars too faint to see in amateur telescopes.

M56 lies about halfway between the blue and gold double star Albireo and Gamma Lyrae (Sulafat). Sulafat is the star in Lyra's parallelogram asterism that lies closest to Albireo.

M56 is the only globular cluster in Lyra. There are approximately 150-catalogued globular clusters in the Milky Way, but astronomers feel there may be close to 200 because dust in the disk of our galaxy obscures our view. Globular clusters contain an enormous number of stars, usually between 100,000 to several million. Unlike galactic star clusters, the amount of mass in globular clusters is sufficient to keep all of the member stars gravitationally bound to the cluster. M56 has a diameter of 8.6 arc minutes and shines at magnitude 8.3. It is nowhere near as large and bright as M13 or M22, but it is still a fine object to view in an 8-inch or larger telescope at high magnification.

M56 is one of the fainter Messier globular clusters. That's because it lies 32,900 light years away. Another reason is that the cluster only contains around 80,000 stars. M56 does not have the

Upcoming Film Will Give a New View of Stellafane

While many of our readers may have known and experienced the iconic Stellafane convention, an upcoming film will highlight a new perspective on the Springfield Telescope Makers — scientific impact and space discovery inspired on Breezy Hill.

Stellafane and Beyond will premiere this summer in conjunction with the annual convention and is the product of documentary film maker Tara Roberts Zabriskie (Moosey Productions).

"This film started as a smaller project in my mind, but after meeting the club members and learning about their deep history and widespread influence on the world of science and space exploration, I realized that there was much more to the story that I needed to tell," said Roberts Zabriskie.

"Over the last century, many of these telescope makers worked on projects for NASA, the military, and the CIA influencing development of space telescopes, spy satellites, and infrared military cameras. I want this film to reach curious minds of all ages and inspire exploration of the art and science of telescopes and amateur telescope making."

Stellafane and Beyond will premiere on August 14, 2026, in Springfield, Vermont (*Stellafane.org*). Moosey Productions is an independent film company focusing on documentary projects that create hope and inspire change in the areas of nature, science, health, and history.

—Dr. James R. Dire



The Astronomical Society of Eastern Missouri invites you to the Mid-States Region 76th Annual Convention

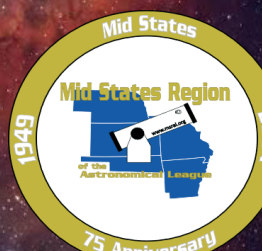
St. Charles County, MO
June 26-28, 2026

Program includes:

- Observing
- Food
- Lectures
- Workshops
- Prizes

And great times with good friends
All regions welcomed!

Website: <https://www.asemonline.org/2026-msral>
Email questions to MSRAL2026@asemonline.org





Amateur Astronomical Spectroscopy and its Value in Scientific Research

Scott P. Donnell
AAVSO Spectroscopy Special Interest Group Lead

INTRODUCTION

Amateur astronomers contribute to astronomical research in a variety of ways, including photometry of variable stars, measuring exoplanet transits, sunspot counting, and monitoring of stellar outbursts, to name a few. I will focus on spectroscopy as a tool to advance astronomical knowledge and how amateur astronomers can make a real impact by providing professional researchers with critical information derived from spectroscopic observations. The information I present here will provide anyone wanting to get started in astronomical spectroscopy with a roadmap to start down that path, as well as provide seasoned amateur spectroscopists guidance in having their observations support astronomical research.

WHAT IS ASTRONOMICAL SPECTROSCOPY AND WHAT CAN IT REVEAL ABOUT THE PHYSICAL PROPERTIES OF ASTRONOMICAL OBJECTS?

Spectroscopy is the dispersion of starlight into its component colors (as shown in figure 1) and the analysis of the dispersed light to determine an astronomical object’s physical properties, such as

- temperatures and spectral types of stars,
- elements present in a stellar photosphere or nebula,
- the temperature and density of the gas within a nebula,
- the presence of and properties of a circumstellar disk or shell,
- expansion velocity of a planetary nebula,
- rotation velocities of stars and galaxies,
- distances to galaxies and quasars,

and much more. In fact, a surprising amount of valuable information can be gleaned by spreading out a star’s light into its component colors.

Much of the equipment used to create spectra is commercially

relative intensity is along the vertical. From these two spectra one can deduce changes in the opacity and therefore density of the nova shell in this interval as well as determine its expansion velocity. Observations such as this and comparisons with other novae provide insight into the nature and evolution of these explosive events.

THE VALUE OF AMATEUR ASTRONOMICAL SPECTROSCOPY

Spectroscopy is one way in which amateur astronomers can make a meaningful contribution to science. Other ways include making visual or photometric observations of variable stars, measuring the periods of eclipsing binary stars, observing exoplanet transits, monitoring flare star activity, and counting sunspots, but spectroscopy offers a much broader window into the physical processes behind the phenomena we observe through our telescopes.

One way that amateur spectroscopists provide value to astronomical scientific investigations is in filling the gaps for professional researchers. While professional researchers have access to large telescopes and instrumentation, this equipment is a resource shared in allocated time slices by many other researchers. This limits the amount of time available for making observations on specific objects of interest. This is where amateur spectroscopists can help. We own our own equipment and have it available for use on any clear night. Our dedicated “always available” capability to generate observations is crucial to fill in the observational gaps necessarily faced by the professional researcher. We can provide critical observations at a higher cadence and over longer time periods and provide data augmenting that of the professional researchers to provide a more complete picture of the physical processes under study. While the large telescopes and sensitive sensors employed by the professionals allows them to “go deeper” than most amateurs,

they generally cannot observe bright objects that would saturate their sensors. That’s where the amateur’s smaller telescopes become an advantage, as we are able to make observations on brighter objects beyond the reach of the professional.

The amateur spectroscopist is therefore well positioned to provide observations supplementing those made by professional astronomers over long time periods, including specific

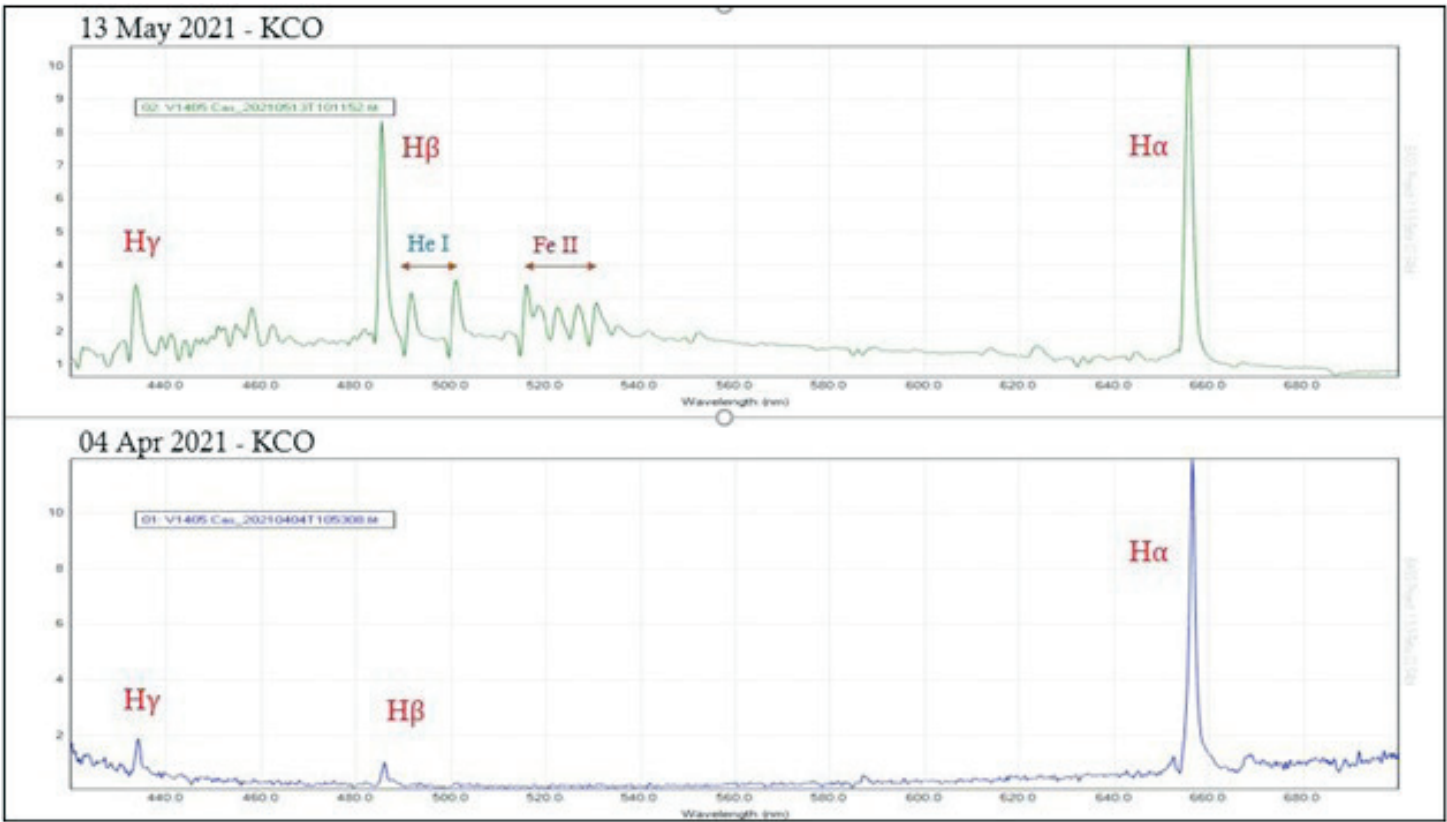


Figure 2. Spectral line evolution of the nova V1405 Cas. Image credit: S. Donnell.

observations as follow-up to professional observations and providing observations of special events such as nova eruptions. The amateur spectroscopist can also engage in individual research or as part of a small group of amateurs and publish their results in scientific journals, such as the *Journal of the American Association of Variable Star Observers* (JAAVSO).

EQUIPMENT USED FOR AMATEUR SPECTROSCOPY

Those getting started in astronomical spectroscopy often start with an inexpensive grating filter and associated software. This approach allows one to “dip one’s toes” in the shallow end of the spectroscopy pool to see if astronomical spectroscopy is for them with only a small expenditure of funds. While these grating filters limit the amount of science that can be accomplished, they are a valuable tool in learning the basic techniques of obtaining and analyzing spectra. From there one can “move up” to more capable spectrographs, leveraging the techniques learned to produce spectra of greater resolution and scientific value. These instruments include moderately priced commercial spectrographs that provide spectra of moderate resolution across the visible spectrum, to more expensive instruments that provide high-resolution spectra over a narrow range of the spectrum. Some instruments are commercially available as 3D-printed kits and can drive down cost in exchange for the user to perform the assembly and calibration.

The resolution provided by a spectrograph is given as R, whose value is given by $\lambda/\Delta\lambda$ (where $\Delta\lambda$ is the width of a spectral line at wavelength λ). Typical R values are 100–300 for low resolution, 600–1,500 for medium resolution, and greater than 10,000 for high-resolution instruments (as shown in figure 3).

TYPES OF SPECTROSCOPIC OBSERVATIONS OF HIGH VALUE

Amateur astronomers can engage in a variety of spectroscopic observations of high scientific value including pulsating variable stars, emission stars, eruptive stars, and eclipsing-disk occulting binary stars. While many of these investigations require a high-resolution spectrograph, there are some for which lower resolution spectra yield valuable information.

MAKING YOUR OBSERVATIONS COUNT!

Many amateur spectroscopists share their observations and findings as presentations or in research journals while others participate in professional-amateur collaborations, such as those organized by the AAVSO. Others choose to simply make their observations available to researchers by submitting their spectra into a repository such as AVSpec, the AAVSO’s database of variable star spectra. However you choose to contribute, your observations will make a positive contribution to ongoing investigations of astronomical objects.

NEXT STEPS FOR THOSE INTERESTED IN PARTICIPATING

If you are interested in getting started in astronomical spectroscopy you will find many resources available to you to guide you along that path. The single best way to get started is to become involved in a group of like-minded individuals involved in astronomical spectroscopy, such as the AAVSO’s Spectroscopy Special Interest Group (forums.aavso.org/g/spectroscopy). This group meets monthly and provides instruction on acquiring and producing astronomical spectra of high quality as well as discussion on topics of interest to the group members. The AAVSO Spectroscopy SIG features a “Targets of the Quarter” program in which one can select targets of observations to either test their skills or demonstrate their proficiency on an object of scientific value.



Figure 1. The light of a star dispersed into its component colors. Image credit: www.rspec-astro.com.

available and, in some cases, can be 3D printed and assembled yourself (although the optics must be purchased). Many of the techniques and skills obtained in doing astrophotography are like those used in astronomical spectroscopy. Figure 2 shows a spectrum I obtained using relatively modest equipment of the nova that appeared in Cassiopeia in early 2021 showing the evolution over a 6-week period of emission lines from hydrogen, helium, and iron. Wavelength is along the horizontal axis and

Object Type	Resolution Required	Scientific Objectives
Pulsating Stars		
RV Tauri variables	High	Spectra will enable studying radial velocity curves and line profiles to examine the complex motions within the atmosphere.
Mira variables	Medium/High	Broad spectrum observations over multiple pulsation cycles can reveal changes to the overall spectrum. High resolution observations can reveal changes in emission lines such as multiple peaks, asymmetric shapes, or sharp absorption components superimposed on emission lines.
Cepheids and RR Lyrae variables	High	Spectroscopy is particularly useful to determine radial velocity curves of the star and explore changes of the line profiles along the pulsation cycle.
Emission Stars		
Chromospherically active stars	Medium/High	Broad spectrum observations to detect changes in emission regions: Hydrogen and Ca II H & K lines (chromospheric emission); Absorption features: Ca II H & K lines. High-resolution observations looking for equivalent width changes.
Wolf-Rayet (WR) outflows	Medium/High	Broad spectrum observations to detect emission lines including highly ionized He, Si, O, N, or C and strong stellar winds with P Cygni absorption profiles and enhanced heavy elements. Observe changes in lines with time as winds evolve and expand. High-resolution observations to study long-term evolution of line profiles and the evolution of P-Cygni signatures, which relate to expansion velocities.
Semi-detached systems	Medium/High	Systematic monitoring with both broadband and high-resolution spectra to provide more comprehensive understanding of these systems.
Eruptive Variables		
Novae	Low/Medium/High	Observations over several weeks after eruption across the visible spectrum reveal changes to the spectral profile indicating changes to the gas density and other physical parameters. Observations of P Cygni profiles of emission lines at high resolution provides estimates on the expansion velocity of the ejected nova shell.
Cataclysmic variables (i.e. dwarf novae)	Medium/High	Observations before and after outburst observe changes in the spectrum that provide insight into the disk's temperature, density, optical depth, and velocity profile.

Other groups involved in amateur astronomical spectroscopy include BeSS (Be Star Spectra) database (*basebe.obspm.fr/basebe/*). Amateurs contribute spectra of Be stars and professionals use these for variability studies and disk modeling. Another is ARAS (Astronomical Ring for Access to Spectroscopy) (www.astrosurf.com/aras/), a network of amateurs

monitoring novae, symbiotic stars, and emission-line objects. Data is shared with professional researchers for long-term monitoring. Additional opportunities for pro-am collaborations in astronomical spectroscopy are found at the Society for Astronomical Sciences (socaastrosci.org/), the *Sky & Telescope* pro-am collaboration hub (skyandtelescope.org/get-involved/pro-

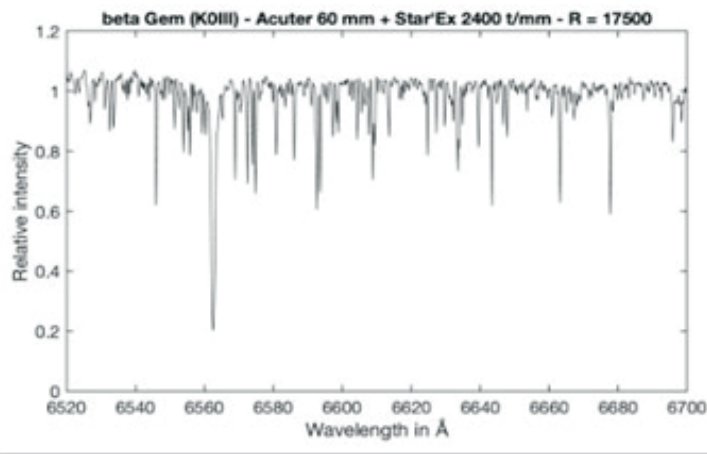


Figure 3. A 3D-printed Star'Ex spectrograph attached to a telescope (top) produces a detailed spectrum (R = 17,500) over a narrow wavelength range (bottom). Image credit: Shelyak Instruments.

am-collaboration/), the International Astronomical Union (IAU) Pro-Am Research Collaboration (PARC) (www.iau.org/WG330/WG330/PARC.aspx), and dedicated sessions at the American Astronomical Society (AAS) annual meetings (aas.org/).

Final Words

If you enjoy visual observing or astrophotography but wish to take your observing to the next level, astronomical spectroscopy may be for you. There are many opportunities for you to contribute to scientific investigation through spectroscopy, and the AAVSO's spectroscopy SIG is a great place to get introduced to others doing spectroscopy and engage in the process of learning how to acquire and process your spectra. If you're not sure, you can try it out using an inexpensive spectral diffraction filter first and decide later if you want to step up to more capable instrumentation. In doing so, you will see how spectroscopy can reveal the secrets of the stars and nebulae you've been visually observing and photographing. It's a wonderful new world of discovery!

Did you know...

The American Association of Variable Star Observers (AAVSO) Solar Section's monthly *Solar Bulletin* is available for free online. Each issue includes a feature article on a sun-related topic, as well as data on recent solar activity (www.aavso.org/SOLAR).

From Stargazing to Science

Whether you're looking at the Moon or tracking storms on Jupiter, as a member of the ALPO your observations become part of the scientific record in the advancement of astronomy.

Memberships start at only \$22/year.

Visit us at www.alpo-astronomy.org/reflector to learn more.

Journal of the Association of Lunar & Planetary Observers
The Strolling Astronomer
Volume 66, Number 1, Winter 2016
More at www.alpo-astronomy.org
Online and in COLOR at <http://www.alpo-astronomy.org>

It never gets old
The Moon (at least most of it)
(See page 3 for details.)

Mutual Events of Galilean Satellites

By Brad Young

Soon after learning about Jupiter and its four Galilean satellites, the next thing many amateur astronomers observe are the events between these satellites and their parent Jupiter. Watching each moon being occulted or eclipsed by Jupiter or transiting and casting its shadow on the giant planet's disc is an interesting thing to watch even years after you have learned about this phenomenon. However, you may find a set of correlating events between the moons themselves even more interesting, although they are much rarer and can be more difficult to observe. These are the mutual events between each moon and one of its sisters, not the disk of Jupiter.

There are, as with the planet, occultations and transits. There are also partial and total eclipses which are visible when the shadow of the closer moon crosses or completely covers the moon behind it. The reason that the events are rare is that they occur during a time when we are passing through the plane of Jupiter's equator over which all the main satellites orbit. Only when they are all in our line of sight can they have mutual events. This occurs around the two equinoxes in Jupiter's 12-year orbital period. The two mutual event "seasons" are spaced about six years apart and centered on one of Jupiter's solstices.

We are coming along to this point next year, and so the events are starting this year and will be visible as soon as Jupiter returns to the morning sky after passing through solar conjunction on July 29, 2026. By September, a few of the brighter mutual events may be visible, although the likelihood of you observing them will increase as the planet gets higher throughout autumn. Several sites and resources are available to plan for these events. I have listed a few below and have shown a partial example output for my location for the upcoming season.

Resources
IMCEE – French campaign to plan and report observations of mutual events of satellites:
www.imcce.fr/recherche/campagnes-observations/phemus/phemu

NASA list of satellite numbering scheme for output of predictions:
naif.jpl.nasa.gov/pub/naif/toolkit_docs/C/req/naif_ids.html#Planets%20and%20Satellites

It is probably interesting also to many readers that there is an Astronomical League (AL) Observing Challenge associated with observing these phenomena. You may be familiar with Galileo's TOES Phase 1 challenge, which deals with the Jupiter-and-its-moons events that many of us are able to see fairly easily. Galileo's TOES Phase 2 is the award for seeing the mutual events and comes in two classifications. One is seeing all the events for a season, such as the upcoming one, and the other is an award (the "Complete" version) for seeing all the events that are possible, which may require more than one season to accomplish. For the

2026–2027 season, it is possible to see all the events and complete both versions of the award. For further details see the Galileo's TOES Phase 2 observing challenge page at the AL site:
www.astroleague.org/galileos-t-o-e-s-phase-2/

To successfully observe these events, it's important to realize they are not quite like their more visible partners with the Jupiter disk. The occultation or transit of one moon by another may not decrease the total magnitude of the two moons by much at all so be prepared and look carefully as the event occurs. With the eclipses, a partial eclipse will of course be more difficult to see than a total eclipse. However, eclipses can occur with the two moons separate from each other, unlike occultations, so it is possible to view one moon seeming to dim while the other remains at the same magnitude. Not all these events are easy to see or very impressive visually or with imaging, but the events are quite interesting when you realize what's happening.

Here is an example of output I adapted from output of the IMCEE site for my location — on September 5 at 5:35 a.m. CDT, Io partially occults Europa for 4.7 minutes:

		TIME CT		DURATION (MIN)	A		B
SEP	5	5:35	4.17	501	OC(P)	502	
SEP	24	4:57	5.54	502	EC(P)	501	
OCT	2	5:10	7.29	502	OC(P)	503	
OCT	14	4:50	4.96	501	EC(A)	502	
OCT	14	5:40	4.51	501	OC(P)	504	
OCT	22	4:19	3.74	504	EC(P)	501	
OCT	26	3:08	6.42	502	EC(P)	501	
OCT	30	2:31	9.37	502	EC(A)	504	
NOV	2	4:26	6.34	502	EC(P)	501	
NOV	4	3:00	7.56	503	EC(P)	502	
NOV	18	2:08	1.12	503	OC(P)	501	
NOV	21	5:32	12.2	502	OC(P)	503	
NOV	25	2:55	4.77	503	EC(P)	501	
NOV	27	12:41	4.16	502	EC(P)	501	
501	'IO'						
502	'EUROPA'						
503	'GANYMEDE'						
504	'CALLISTO'						

Other data included in the output (not shown here) will help determine the suitability of an event. For instance, the September 5th event above also has these parameters.

I	Δf (%)	D (r)	S (")	H (°)	H $\odot$ (°)	Phase $\subset$ (°)	e $\subset$ (°)
0.29	32	2.71	0.22	10.3	-16.8	104.6	46.5
I	Impact parameter — from 0 for a central phenomenon to 1 for a grazing phenomenon.						
Δf	Maximum flux drop.						
D	Distance from the satellite undergoing the phenomenon to the limb of the planet, referred to the apparent radius of the planet in the direction of the satellite at the maximum.						
S	Angular distance between the two bodies involved at the time of the maximum.						
H	Elevation of the planet (without refraction) with respect to the horizon.						
H $\odot$	Elevation of the Sun (without refraction) with respect to the horizon.						
Phase $\subset$	Phase of the Moon.						
e $\subset$	Elongation between the planet and the Moon — angle between the Earth-planet's direction and the Earth-Moon direction.						

So, we see it is an impactful event, with 32% of the flux (brightness) diminished for the pair, and it is 2.7 Jupiter radii away from Jupiter. The planet is 10° up and the Sun still 17° below the horizon, so it would be a challenge but is visible. The waning moon is 47° away and not an issue.

Note that the output is very complete and you may want to filter Jupiter events, those of lesser moons, and change formats.

What did Hubble See on Your Birthday?

NASA has a webpage that allows you to answer this fun question (science.nasa.gov/mission/hubble/multimedia/what-did-hubble-see-on-your-birthday/).

UNLOCK THE UNIVERSE

SKY&TELESCOPE



ONE SUBSCRIPTION.
TWO WAYS TO EXPLORE.



Discover the sky, the science, and the tools that bring the universe to you—get both the magazine and full access to exclusive articles at skyandtelescope.org

SUBSCRIBE



12 REFLECTOR ★ JUNE 2026

THE ASTRONOMICAL LEAGUE 13

Observing the Moon

by Theresa Summer
Astronomical Society of the Pacific

INTERNATIONAL OBSERVE THE MOON NIGHT: EVERYONE, EVERYWHERE, EVERY YEAR

Last year, an estimated one million people in 129 countries participated in International Observe the Moon Night (science.nasa.gov/moon/observe-the-moon-night/). But that number almost misses the point. What happened was simpler and more profound: on one night, all over the world, people looked up together at our Moon.

The Moon can be a favorite object for amateurs, or it can be that bright interloper washing out your deep-sky targets! Which ever camp you're in, almost everyone has a favorite memory or a personal connection with our nearest neighbor. And International Observe the Moon Night celebrates those connections around the globe.

The event started on September 18, 2010, when lunar enthusiasts around the world gathered for the inaugural International Observe the Moon Night. But the spark happened earlier than that — it started the way the best ideas often do: a group of Lunar Reconnaissance Orbiter (LRO) scientists, some drinks, and a conversation that turned into a plan. What began as a spontaneous idea has grown into one of the largest coordinated public astronomy events on the planet — and it keeps getting bigger.

JOIN US ON SEPTEMBER 19, 2026

This year's International Observe the Moon Night is centered on September 19, 2026 — but participation extends through the week before and the week after, giving you plenty of flexibility to find the right moment for your community. You can host a public star party, organize a club observing session, or simply

set up in your backyard. Events can be in-person or virtual, large or intimate. For astronomy clubs, this is one of the best public outreach opportunities of the year. The Moon is endlessly accessible to newcomers, but it's still meaningful, even for experienced observers. And your participation will connect you to the worldwide community!

TIPS FOR HOSTING A GREAT EVENT

Hosting an International Observe the Moon Night event doesn't have to be complicated — a few telescopes, a printed Moon map, and a friendly explainer about the lunar surface can turn a curious passerby into a lifelong stargazer. If you're planning a public event, consider setting up near a library, school, or community center to draw foot traffic, and have a "cloudy night" backup plan ready, such as a lunar slideshow or a NASA video (science.nasa.gov/moon/observe-the-moon-night/rain-or-shine-moon-resources/). Each year, the Astronomical Society of the Pacific (ASP) hosts a free virtual webinar in July for event organizers, sharing practical tips, resources, and lessons learned from hosts around the world — keep an eye on the ASP website for this year's date and registration link.

Registration for International Observe the Moon Night 2026 opens this summer. In the meantime, sign up for NASA's newsletter (science.nasa.gov/moon/observe-the-moon-night/newsletter/) to get updates, observing tips, and lunar science highlights delivered straight to your inbox.

Visit go.nasa.gov/ObserveTheMoon to explore resources and get notified when registration opens. One Moon — Everyone, Everywhere, Every Year. This year we hope that means you and your community!



Photo by Soham Pattnaik

2025 Ecology Review: The Hidden Cost of Light Pollution on Wildlife

by Bill McGeeney,
Light Pollution News

Many people don't realize the true magnitude of the impact of artificial light at night. It's not that artificial light itself is inherently dangerous, nor is it true that we shouldn't have any artificial light. Rather, in our modern world, we lack any responsible behavior with our lighting, creating a hazardous nighttime environment that offers little protection for mammals, insects, and even plants/trees. While you may have the ability to just "close the curtain," nature doesn't.

I put this teaser together regarding the most impactful ecology- and environment-related research and news articles during the 24 Light Pollution News podcast episodes from 2025. You can find the full details on the 49 research and news articles at the link below. Unlike persistent chemical contaminants, many of these ecological impacts can be quickly reversed once communities commit to simply being responsible with their lighting.

For the complete review with links to all research articles, visit lightpollutionnews.com/research/2025-review-impact-of-artificial-light-at-night-on-environment.

UNDERGROUND IMPACTS

A nine-year field study documented how blue-spectrum streetlights reduce earthworm populations and biomass while disrupting soil-aggregation patterns. When researchers tested whether grass spiders prioritize prey or light when building webs, 79% of light-exposed spiders chose illuminated corners without prey over dark corners with abundant insects. The United Kingdom's radar network for weather tracking from 2014–2021 revealed consistent nocturnal insect declines, especially moths in northern regions, with both day and night species avoiding light-saturated areas.

AVIAN DISRUPTION

Experiments on Atlantic puffin fledglings in Newfoundland showed young birds chose every illuminated path regardless of bulb type: sodium vapor and all LED wavelengths attracted equally. Researchers concluded only eliminating coastal lighting during fledging prevents puffin strandings. Global studies

document song birds extending daily activities unnaturally under nighttime brightness, with compromised immune function in lit environments. Species-specific vulnerabilities require tailored conservation approaches.

AQUATIC SYSTEM CHANGES

Coral-reef experiments revealed 25 consecutive nights of illumination kept daytime-hunting fish active after dark, fundamentally altering predator-prey timing. Young salmon face heightened predation where lights reach waterways, while amphipods show sex-specific responses potentially skewing population ratios. Coastal lighting links to harmful algal blooms, with extended light exposure favoring toxic varieties.

CONSERVATION PROGRESS

Hawaiian Electric lawsuits established enforceable deadlines for lighting modifications protecting seabirds. Houston and Philadelphia Lights Out campaigns measured real reductions in migration-period bird deaths. Motion-activated LED systems cut bat exposure while preserving safety. Spectral research confirms amber and red wavelengths harm insects less than blue-heavy white light. Lake Erie communities voluntarily darken streetlights during mayfly emergences, while Austin integrated window treatments with strategic lighting placement. Evidence shows mandatory regulations paired with architectural standards remain essential for wildlife protection at scale.



Pro – Am Astronomer Workshop

and the

ASTROBLAST 26 Star Party

October 5 - 11 | www.oras.org

The International Astronomical Union Pro-Am Working Group and the Oil Region Astronomical Society are combining efforts this year to host two exciting events in NW Pennsylvania.

2026 International Pro-Am Workshop takes place Oct. 5-8 at Camp Coffman and the Oil Region Astronomy Learning Center. The event brings together professional and amateur astronomers to develop and plan research collaborations to advance astronomical discoveries.

ASTROBLAST 2026 is an annual star party taking place in dark sky country at the Oil Region Astronomy Learning Center Oct. 6 - 11. The event is open to amateur astronomers as well as others who are interested in astronomy or learning more about our universe; you don't need a telescope to attend, [just a curious mind!](#)

REGISTER TODAY at www.oras.org | Pre-registration Ends Aug. 1

From Eyepiece to Image: My Journey from Visual Observing to Astrophotography

By Carl J. Wenning
Twin City Amateur Astronomers

Astronomical imaging by amateur astronomers has become extremely popular in recent years. Today, amateur astronomers achieve impressive results with relatively inexpensive CMOS cameras and small telescopes — mostly refractors. Previously, the best work required expensive CCD cameras and large reflecting telescopes. With CMOS cameras, improved telescope optics, and advanced controllers such as Eagle, StellarMate, NINA, and ASIAIR, amateur astronomers are now achieving with small telescopes what only advanced amateurs and professionals could do a decade or two ago with much larger instruments.

I began viewing the night sky in July 1957, after my grandfather introduced me to the heavens. I was so intrigued by what I saw that I went on to earn an undergraduate degree in astronomy in 1976. I have since been an avid amateur



A simple visual set-up with CPC 8" in altazimuth configuration, two finders, and an eyepiece

astronomer. For the past half-century, I have been primarily a visual observer. I preferred to spend my time peering through glass rather than producing images. My attitude stemmed from my impression that astrophotography was more of a pain than a joy. It arose during my time as an astronomy major at The Ohio State University, when I regularly imaged with the Perkins Observatory's 16-inch/24-inch Schmidt camera, using 3X3-inch glass plates coated with thin layers of light-sensitive emulsion. Focusing was a significant problem because I had to capture image after image on the same photographic plate (each time offsetting a bit from the prior position), then return to the darkroom to "develop, stop, and fix" that plate before I could examine it for best focus. Only then could the real imaging begin. It was then that I lost interest in astrophotography.

Over the years, I watched fellow amateur astronomers experience the joys (and frustrations!) of film-based astrophotography (including gas hypering and cold cameras), and then of digital astronomical imaging with DSLRs or dedicated astronomical cameras. I was convinced by their trials and tribulations that image capture and post-processing were hardly worth it and definitely not for me. Astrophotography seemed more like painful art than productive science. While I realized that others enjoyed capturing details unseen by the eye and sharing their beauty through photographs, I was content to look at images obtained with the world's great telescopes. What's the difference? Then, slowly, over the years, my attitude began to change.

THE TURNING POINT

While I valued seeing "the real thing" through an eyepiece, I also realized that over the past five decades I'd done little more than view the same celestial objects time and again. I then augmented my views of the heavens by using a military-grade image intensifier with infrared and H-alpha filters and a 20-inch telescope. This opened a whole new universe for me and held my interest for another five years. Still, I was not entirely satisfied with my observing experiences.

I wanted to see more detail and color, both of which were mostly absent in my visual observations. Previously, I was impressed by "controllers" (e.g., StellarMate, Eagle, and ASIAIR) and how they controlled the process of finding objects, guiding on



CPC 8" on equatorial wedge configured for imaging with ASIAIR 585MM camera, ASIAIR mini controller, and a Starizona counterweight system. Not shown are cables, filter wheel assembly, camera angle adjuster, and automatic electronic focuser.

them, and taking light, flat, dark, and bias frames, all with a few clicks in an app on a tablet or mobile phone. The availability of this new technology and its influence on astrophotography finally made a difference for me. I was deeply impressed by their ability to "live stack" and see things I'd never seen before through an eyepiece. I was enamored by the ability to make a permanent digital record of my observations.

The final nail in the coffin of exclusive visual observing was seeing how simple it was to operate an AS585MM CMOS camera and manage a telescope with an ASIAIRmini controller. I was impressed by the ability to program light, dark, flat, and bias images, change filters, perform automatic focusing, and even adjust camera orientation. Sure, my club's more expensive camera systems could do this, but I was impressed by how easy it was to use the ZWO app on my iPad. I was hooked.

What further impressed me was my ability to image even from my brightly lit backyard. Before long, I had my CPC 8-inch mounted on an equatorial wedge and made my first images at f/10. I then used a telecompressor/flattener to reduce the f-number to 6.3, yielding a wider field and brighter images on the focal plane. I was so enamored of the results that I purchased an 80mm f/7 refractor to gain still wider fields of view. After succeeding with basic black-and-white photography, I soon longed to start using filters to capture color images and accessories to control various aspects of the imaging process.

FIRST STEPS IN COLOR ASTROPHOTOGRAPHY

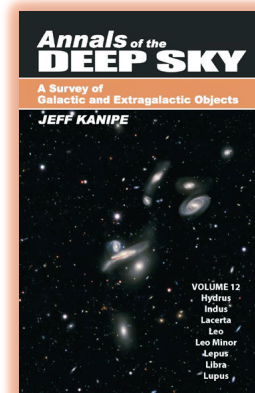
Learning to create color images with filters and a monochrome camera can be daunting. Because I intended to be self-taught and learn best by writing about something, I prepared TCAA Guide #13: Imaging with Dedicated Digital Astronomy Cameras (tcaa.club/guides) to organize and systematize my knowledge and document my learning process. This document also helps others pick up the color imaging process from the ground up. Of course, many YouTube videos do the same thing, but writing aligns with my learning style.

I made essential gear upgrades over the last Christmas holidays to take advantage of seasonal discounts. Having earlier acquired a five-position filter wheel and RGB and SHO filter sets from friends, I purchased an electronic automatic focuser with a temperature sensor and a camera angle adjuster at discounted prices. Adding these items to the back of the telescope produces considerable torque, which must be compensated for if the telescope is to remain in balance, so I purchased an "over and under" counterweight set for my CPC 8-inch. (I have yet to acquire a guide camera, as most of my exposures are currently in the 5- to 10-second range.)

As I've continued to learn about imaging and processing, I've also come to appreciate the importance of planning and patience, more so than in visual observing. The two types of astronomy are considerably different. With imaging, the days when I could flit from object to object at will are gone. Now I must carefully consider my targets, the telescope I use, and program each step

COMING SOON!

SKY&TELESCOPE



Annals of the Deep Sky A Survey of Galactic and Extragalactic Objects

VOLUME 12 | by Jeff Kanipe

Volume 12 of the beloved *Annals of the Deep Sky* series will explore the constellations Hydrus through Lupus, featuring celestial objects such as Hind's Crimson Star and the Leo Triplet.

Stay tuned for preorder details on shopatsky.com!



To explore other titles in the series,
visit shopatsky.com



of the imaging process. While I can still produce live-stacked images, creating incredible color images requires exacting, detailed work.

THE ROLE OF ASTROPHOTOGRAPHY CONTROLLERS

After learning about astronomical software and controllers such as MaximDL, StellarMate, NINA, Eagle, ASIAIR, and others, I’ve come to see them as the brains of a good imaging setup. They can be used not only to automate complex tasks such as object finding, guidance, focusing, and exposure control, but also to plan the steps required to achieve the best possible images.

The benefits of using controllers are numerous and varied. For instance, they streamline image-capture workflows, enable remote operation, and automate imaging sessions. They fully integrate a system that includes telescopes, cameras, mounts, guiders, focusers, camera rotators, and filter wheels.

Working with controllers has made my transition from the eyepiece to imaging both smoother and more enjoyable. The only question I still need to answer is, “Why did I wait so long?”

LESSONS LEARNED AND TIPS FOR BEGINNERS

Here are a few tips that might help you undertake a similar journey:

- Start simple. Don’t overcomplicate your system at first. Buy new items as you need them and learn how to use each as you go. Starting with everything at once can steepen the learning curve and make it seem overwhelming.
- Learn the basics of polar alignment and guiding. These are essential for imaging. Equatorial mounts are essential for long exposures because altazimuth mounts will cause detectable image rotation even with relatively short exposures.
- Invest in reliable power and data management. One of the biggest problems amateur astronomers face with automated systems like these is underpowering them, which leads to frequent Wi-Fi connection drops and underperformance.
- Embrace the learning curve. Recognize that mistakes are part of the process and that learning takes time. Read, watch YouTube videos, and ask those already in the know how to solve problems and avoid certain situations. This is essential to your growth as an amateur astronomer.
- Join social media groups focused on solving challenges associated with using this advanced technology.
- Realize that setting up photographic equipment is more complicated than setting up visual equipment. Setting up and leveling the pier and mount, attaching imaging equipment and a controller, balancing the system, routing and managing cables, and polar aligning take considerably longer. It would be advisable to have a semi-permanent placement for one’s imaging system.

Most of what I have learned (and will yet learn) has been (and will be) documented in Twin City Amateur Astronomers (TCAA) Guide #13, which I consider a “living document.” This freely available online publication will be updated in the near term as I learn more about color imaging and the image-processing work that necessarily follows the initial photographic process.

THE EYEPIECE-TO-IMAGE JOURNEY

Astrophotography has added a new dimension to my experience of the night sky. Today, I still eagerly anticipate each

view through an eyepiece. I’m still overwhelmed by what I see through an image intensifier and a large telescope. Yet with astrophotography, I’m drawn to the challenge of producing the best images I can with the system I have. Looking at images from the Hubble or James Webb space telescopes is not necessarily better than viewing lower-quality images produced as a labor of love.

I encourage others to consider making the journey from eyepiece to image. It’s not about forsaking one for the other. All it does — and this is no minor thing — is to broaden your view of the heavens and give you yet one more way to appreciate and share what’s out there.

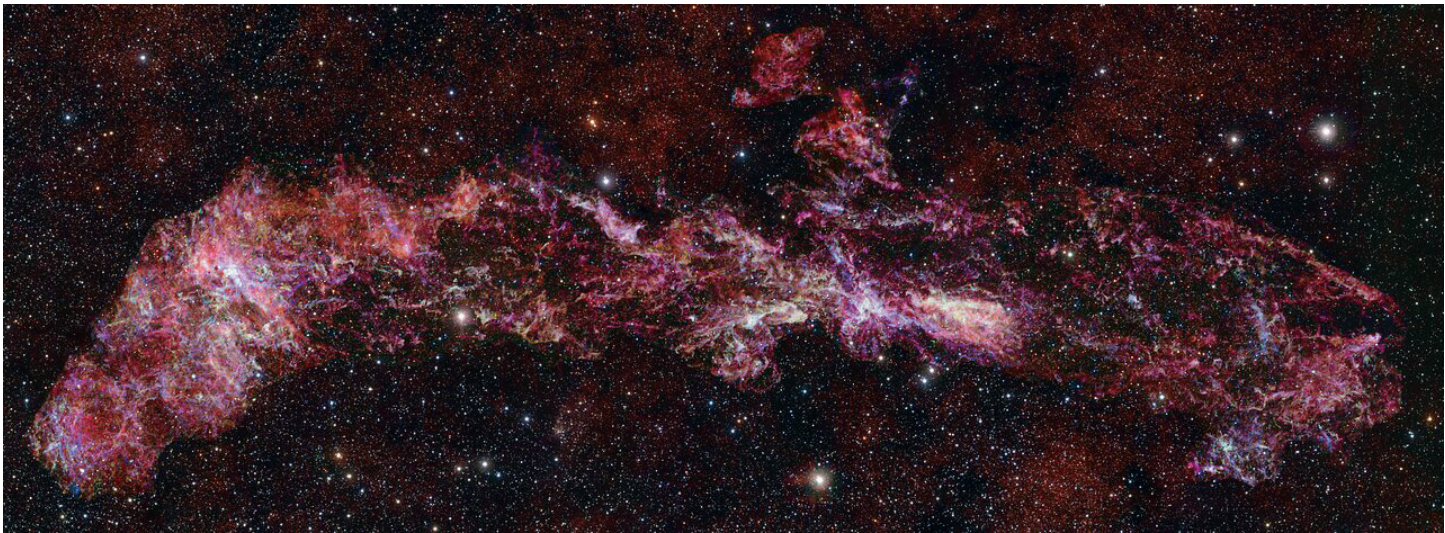
I look forward to learning more about how to use my imaging system effectively. Not only is there deep-sky imaging but also solar, lunar, planetary, and cometary imaging to explore. There is also the possibility of studying variable stars. The horizon awaits!

How Old is Starlight?

Timothy Ferris created a webpage that lists stars at various distances, allowing you to find starlight that matches your age (www.pbs.org/seeinginthedark/explore-the-sky/birthday-stars.html). For example, if you are 60 years old, the light you see tonight from the star Navi in Cassiopeia began its celestial journey in the year you were born. While some of these distances may have been updated since the webpage’s creation, it is a creative and fun way to introduce the concept of look-back time — whenever we look up into the night sky we are looking back in time, due to the finite speed of light.

Largest Image of Its Kind Shows Hidden Chemistry at the Heart of the Milky Way

— Adapted from the ESO press release (www.eso.org/public/news/eso2603/)



Largest ALMA image ever shows the molecular gas in the center of the Milky Way

Astronomers using the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile have generated their largest image to date, peering into the central region of our Milky Way.

“It’s a place of extremes, invisible to our eyes, but now revealed in extraordinary detail,” says Ashley Barnes, an astronomer at the European Southern Observatory (ESO) in Germany, part of the 160-member ACES (ALMA CMZ Exploration Survey) team that obtained the new data. The observations provide a unique view of the cold gas — the raw material from which stars form — within the so-called Central Molecular Zone (CMZ) of our galaxy. It is the first time the cold gas across this whole region has been explored in such detail.

The region featured in the new image spans more than 650 light-years. It harbors dense clouds of gas and dust, surrounding the supermassive black hole at the center of our galaxy. “It is the only galactic nucleus close enough to Earth for us to study in such fine detail,” says Barnes. The dataset reveals the CMZ like never before, from gas structures dozens of

light-years across all the way down to small gas clouds around individual stars.

With ACES, astronomers hope to better understand how these phenomena influence the birth of stars and whether our theories of star formation hold in extreme environments.

Seen in the sky, the mosaic — obtained by stitching together many individual observations like putting puzzle pieces together — is as long as three full Moons side-by-side.



Location of the Central Molecular Zone in the Milky Way

OBSERVING AWARDS

COMET 31/ATLAS OBSERVING CHALLENGE

Mike McCabe, South Shore Astronomical Society; **Jody Raney**, Shreveport-Bossier Astronomical Society; **Charles Urban**, Shreveport-Bossier Astronomical Society; **Greg Ruppel**, Tucson Amateur Astronomers Association; **Lauren Rogers**, Escambia Amateur Astronomers Association; **Jon Adams**, Member-at-Large; **Cran Lucas**, Shreveport-Bossier Astronomical Society; **Dan Crowson**, Astronomical Society of Eastern Missouri; **Brad Young**, Astronomy Club of Tulsa; **Blair Grodon**, Raleigh Astronomy Club; **David E. Johnson**, Independent; **Dana R. Bostic**, Raleigh Astronomy Club; **Doug Lively**, Raleigh Astronomy Club; **Dean F. Herring**, Raleigh Astronomy Club; **Susan Herring**, Raleigh Astronomy Club; **Adrian Newland**, Independent; **Darryl Carlyle-Moses**, Member-at-Large; **Al Hamrick**, Raleigh Astronomy Club; **Russell F. Pinizzotto**, Southern Maine Astronomers Club; **Douglas Balogh**, Indiana Astronomical Society; **Laurie V. Ansorge**, Lifetime Member; **Randy Rogge**, Denver Astronomical Society; **Scott Bratt**, Astronomy Club of Tulsa; **Mike Simmons**, Southern Maine Astronomers; **Jeffrey S. Moorhouse**, La Crosse Area Astronomical Society; **David Hasenauer**, Astronomy Section of the Rochester Academy of Science; **Mike Gent**, Austin Astronomical Society; **John Robert Parsons**, Raleigh Astronomy Club; **Dave Mitsky**, Delaware Valley Amateur Astronomers; **Jeff Goldstein**, Back Bay Amateur Astronomers; **Steve Boerner**, Member-at-Large

HUBBLE 35TH ANNIVERSARY SPECIAL OBSERVING CHALLENGE

Roy Antonio, Nov., Dec., Member-at-Large; **David Arbol**, Dec., Independent; **Mohammad Adnan Asif**, Dec., Raleigh Astronomy Club; **Mustafa M. Asif**, Dec., Raleigh Astronomy Club; **Chester Austin**, Oct., Nov., Dec., Member-at-Large; **Robert Beuerlein**, Nov., Dec., NASA Langley Exchange Skywatchers; **Heidi Bjerke**, Dec., Champaign-Urbana Astronomical Society; **Saul Blanco**, Oct., Nov., Dec., Independent; **Bruce P. Bookout**, Dec., Colorado Springs Astronomical Society; **Darryl Carlyle-Moses**, Dec., Member-at-Large; **Dana Bostic**, Dec., Raleigh Astronomy Club; **Sean Clunn**, Dec., Independent; **James Collins**, Dec., Albuquerque Astronomical Society; **Keith Courter**, Nov., Dec., Member-at-Large; **Dan Crowson**, Dec., Astronomical Society of Eastern Missouri; **Paul DeVoe**, Dec., Member-at-Large; **Jim Dole**, Dec., Planetary Studies Foundation; **Larry Dove**, Dec., Flint River Astronomy Club; **Steven Emenhiser**, Oct., Nov., Dec., Colorado Springs Astronomical Society; **Silvia Fernandez**, Dec., Independent; **James Fouch**, Dec., Denver Astronomical Society; **Joe Fragola**, Dec., TAC-AL; **Mary Ann Francis**, Dec., Independent; **Jeff Francis**, Dec., Independent; **Carlos Gaceo**, Dec., Independent; **Jose Vicente Gavilanes**, Dec., Independent; **Antonio Gomez**, Dec., Independent; **Guillermo Gonzalez**, Dec., Independent; **Sergio Gonzalez**, Dec., Independent; **Blair Groden**, Dec., Raleigh Astronomy Club; **Dave Halupowski**, Dec., Escambia Amateur Astronomers Association; **Al Hamrick**, Dec., Raleigh Astronomy Club; **Kevin Hartnett**, Dec., Goddard Astronomy Club; **Jessica Hatfield**, Nov., Dec., Independent; **Naia Helms**, Sep., Oct., Nov., Dec., Independent; **Nowell Helms**, Dec., Independent; **Rick Heschmeyer**, Dec., Astronomy Associates of Lawrence; **Chris Kagy**, Dec., Northern Virginia Astronomy Club; **Michael Keefe**, Dec., Raleigh Astronomy Club; **Francisco Laiz**, Dec., Independent; **Paul Liamazares**, Dec., Independent; **Marie Lott**, Dec., Atlanta Astronomy Club; **Edward Magowan**, Dec., Escambia Amateur Astronomers Association; **Fernando Martinez**, Dec., Independent; **Rafael Matias**, Dec., Independent; **Ralph McConnell**, Nov., Dec., Barnard Astronomical Society; **Scott McInnis**, Nov., Dec., NASA Langley Exchange Skywatchers; **Brittney Miller**, Dec., Atlanta Astronomy Club; **Jeffery S. Moorhouse**, Oct., Nov., Dec., La Crosse Area Astronomical Society; **Paul Morgan**, Dec., Umpqua Astronomers; **Eva Nava**, Dec., Independent; **Adrian Newland**, Nov., Dec., Independent; **Angele Mott-Nickerson**, Nov., Dec., Rose City Astronomers; **Dean Ostergaard**, Dec., Southern Maine Astronomers; **Kirk Parnell**, Dec., Shreveport-Bossier Astronomical Society; **Nathan Paskach**, Dec., Independent; **Jody Raney**, Dec., Shreveport-Bossier

Astronomical Society; **Rob Ratkowski**, Dec., Haleakala Amateur Astronomers; **Nathan Raynor**, Oct., Nov., Dec., Raleigh Astronomy Club; **Beatriz de la Red**, Dec., Independent; **Greg Rigelman**, Dec., St. Louis Astronomical Society; **Rachel Ryan**, Oct., Nov., Dec., Colorado Springs Astronomical Society; **Hector Sanchez**, Dec., Independent; **Roberta Shaner**, Dec., Delaware Valley Amateur Astronomers; **Kendal Shipley**, Dec., Barnard Astronomical Society; **Jennifer Siders**, Dec., Tri-Valley Stargazers; **Michael Simmons**, Nov., Dec., Southern Maine Astronomers; **Henry Skirbst**, Nov., Dec., Member-at-Large; **Karen Smith**, Nov., Dec., Independent; **Teresa Torregimeno**, Dec., Independent; **Charles Urban**, Dec., Shreveport-Bossier Astronomical Society; **Bernard Venasse**, Nov., Dec., Lifetime Member; **Nicole Walker**, Nov., Dec., Colorado Springs Astronomical Society; **David Warner**, Nov., Dec., Colorado Springs Astronomical Society; **Richard Wheeler**, Nov., Dec., Northeast Florida Astronomical Society; **Ronan Wilson**, Nov., Dec., Independent; **Chris Wittum**, Nov., Dec., Raleigh Astronomy Club; **Douglas Woods**, Dec., Central Florida Astronomical Society; **Kelsey Yocum**, Oct., Nov., Dec., Rose City Astronomers; **Brad Young**, Dec., Astronomy Club of Tulsa

HUBBLE 35TH ANNIVERSARY SPECIAL OBSERVING CHALLENGE – GOLD LEVEL

Roy Antonio, Member-at-Large; **David Arbol**, Independent; **Mohammad Adnan Asif**, Raleigh Astronomy Club; **Chester Austin**, Member-at-Large; **Robert Beuerlein**, NASA Langley Exchange Skywatchers; **Heidi Bjerke**, Champaign-Urbana Astronomical Society; **Saul Blanco**, Independent; **Bruce P. Bookout**, Colorado Springs Astronomical Society; **Darryl Carlyle-Moses**, Member-at-Large; **Dana Bostic**, Raleigh Astronomy Club; **James Collins**, Albuquerque Astronomical Society; **Keith Courter**, Member-at-Large; **Dan Crowson**, Astronomical Society of Eastern Missouri; **Paul DeVoe**, Member-at-Large; **Jim Dole**, Planetary Studies Foundation; **Larry Dove**, Flint River Astronomy Club; **Steven Emenhiser**, Colorado Springs Astronomical Society; **Silvia Fernandez**, Independent; **James Fouch**, Denver Astronomical Society; **Joe Fragola**, TAC-AL; **Mary Ann Francis**, Independent; **Jeff Francis**, Independent; **Carlos Gaceo**, Independent; **Jose Vicente Gavilanes**, Independent; **Antonio Gomez**, Independent; **Guillermo Gonzalez**, Independent; **Sergio Gonzalez**, Independent; **Blair Groden**, Raleigh Astronomy Club; **Dave Halupowski**, Escambia Amateur Astronomers Association; **Al Hamrick**, Raleigh Astronomy Club; **Kevin Hartnett**, Goddard Astronomy Club; **Jessica Hatfield**, Independent; **Naia Helms**, Independent; **Nowell Helms**, Independent; **Dean Herring**, Raleigh Astronomy Club; **Susan Herring**, Raleigh Astronomy Club; **Rick Heschmeyer**, Astronomy Associates of Lawrence; **Chris Kagy**, Northern Virginia Astronomy Club; **Michael Keefe**, Raleigh Astronomy Club; **Francisco Laiz**, Independent; **Paul Liamazares**, Independent; **Doug Lively**, Raleigh Astronomy Club; **Marie Lott**, Atlanta Astronomy Club; **Edward Magowan**, Escambia Amateur Astronomers Association; **Fernando Martinez**, Independent; **Rafael Matias**, Independent; **Ralph McConnell**, Barnard Astronomical Society; **Scott McInnis**, NASA Langley Exchange Skywatchers; **Brittney Miller**, Atlanta Astronomy Club; **Jeffery S. Moorhouse**, La Crosse Area Astronomical Society; **Paul Morgan**, Umpqua Astronomers; **Eva Nava**, Independent; **Adrian Newland**, Independent; **Angele Mott-Nickerson**, Rose City Astronomers; **Dean Ostergaard**, Southern Maine Astronomers; **Kirk Parnell**, Shreveport-Bossier Astronomical Society; **Nathan Paskach**, Independent; **Jody Raney**, Shreveport-Bossier Astronomical Society; **Rob Ratkowski**, Haleakala Amateur Astronomers; **Nathan Raynor**, Raleigh Astronomy Club; **Beatriz de la Red**, Independent; **Greg Rigelman**, St. Louis Astronomical Society; **Rachel Ryan**, Colorado Springs Astronomical Society; **Hector Sanchez**, Independent; **Roberta Shaner**, Delaware Valley Amateur Astronomers; **Kendal Shipley**, Barnard Astronomical Society; **Jennifer Siders**, Tri-Valley Stargazers; **Michael Simmons**, Southern Maine Astronomers; **Henry Skirbst**, Member-at-Large; **Karen Smith**, Independent; **Teresa Torregimeno**, Independent; **Charles Urban**, Shreveport-Bossier Astronomical Society; **Bernard Venasse**, Lifetime Member; **Nicole Walker**, Colorado Springs Astronomical Society; **David Warner**, Colorado Springs Astronomical Society; **Richard Wheeler**, Northeast Florida Astronomical Society; **Ronan Wilson**, Independent; **Chris**

Wittum, Raleigh Astronomy Club; **Douglas Woods**, Central Florida Astronomical Society; **Kelsey Yocum**, Rose City Astronomers; **Brad Young**, Astronomy Club of Tulsa

ADVANCED BINOCULAR DOUBLE STAR OBSERVING PROGRAM

No. 71, Eric Hanson, Member-at-Large

ANALEMMA OBSERVING PROGRAM

No. 26, Dave Rudeen, Etna Astros; **No. 27, Karl A. Schultz**, Central Arkansas Astronomical Society

ARP PECULIAR GALAXIES SOUTHERN OBSERVING PROGRAM

No. 26-I, Lauren Rogers, Escambia Amateur Astronomers Association

ASTERISM OBSERVING PROGRAM

No. 43, Kevin Carr, Binocular, Minnesota Astronomical Society; **No. 103, Dean Herring**, Regular, Raleigh Astronomy Club; **No. 104, Susan Herring**, Regular, Raleigh Astronomy Club; **No. 105, Eric Hanson**, Binocular, Member-at-Large; **No. 106, Jill Sinkwich**, Eyes Only & Binocular, Member-at-Large

ASTEROID OBSERVING PROGRAM

No. 87-I, Brad Young, Gold, Astronomy Club of Tulsa

BEYOND POLARIS OBSERVING PROGRAM

No. 82, Paul Cipriani, Member-at-Large; **No. 83, Darryl Carlyle-Moses**, Member-at-Large

BINOCULAR DOUBLE STAR OBSERVING PROGRAM

No. 228, Jon Adams, Member-at-Large

BINOCULAR MESSIER OBSERVING PROGRAM

No. 1282, Simon Lowther, Member-at-Large; **No. 1283, Ernie Mastroianni**, Shoreline Astronomical Society; **No. 1284, William H. Vining**, Riverside Astronomical Society; **No. 1285, Mitchell Christopher**, Bear Valley Springs Astronomy Club

CALDWELL IMAGING PROGRAM

No. 17, Michael Goldstein, Silver, Albuquerque Astronomical Society; **No. 18, Steve Boerner**, Silver, Member-at-Large

CALDWELL OBSERVING PROGRAM

No. 310, Angele Mott Nickerson, Silver, Rose City Astronomers; **No. 38, Christian Weis**, Gold, Tucson Amateur Astronomy Association; **No. 311, Katrina DeWitt**, Silver, Northeast Wisconsin Stargazers

CITIZEN SCIENCE SPECIAL PROGRAM

Dan Crowson, Gold Class 8, Active, IASC Asteroid Search, Astronomical Society of Eastern Missouri; **Al Lamperti**, Gold Class 579, Active, Active Asteroids, Delaware Valley Amateur Astronomers; **Al Lamperti**, Gold Class 48, Galaxy Zoo, Cloudspotting on Mars, Delaware Valley Amateur Astronomers; **Al Lamperti**, Gold Class 8, Supernova Host Herding, Delaware Valley Amateur Astronomers; **Al Lamperti**, Gold Class 36, Space Warps, ESA Euclid, Delaware Valley Amateur Astronomers; **Lauren Rogers**, Gold Class 2, Rubin Comet Catchers, Escambia Amateur Astronomers Association; **Brad Young**, Gold Class 20, Observational, Variable Stars, Astronomy Club of Tulsa; **Brad Young**, Gold Class 21, Observational, Variable Stars, Astronomy Club of Tulsa; **Brad Young**, Gold Class 36, Observational, EOSOP, Astronomy Club of Tulsa

COMET OBSERVING PROGRAM

No. 73, Jim Kvasnicka, Gold, Prairie Astronomy Club; **No. 149, David Sharp**, Silver, Tucson Amateur Astronomy Association; **No. 150, Scott Bratt**, Silver, Astronomy Club of Tulsa; **No. 151, Ken Boquist**, Silver, Popular Astronomy Club

CONSTELLATION HUNTER NORTHERN SKIES OBSERVING PROGRAM

No. 344, Jon Adams, Member-at-Large; **No. 345, Mohammad**

Adnan Asif, Raleigh Astronomy Club; **No. 346, Mike Gent**, Austin Astronomical Society; **No. 347, Pedro Cabanillas**, West Kentucky Amateur Astronomers

DARK NEBULA OBSERVING PROGRAM

No. 44-I, Eric Edwards, Lifetime Member

DOUBLE STAR OBSERVING PROGRAM

No. 728, Christian Weis, Tucson Amateur Astronomy Association

EXTRAGALACTIC OBJECTS OBSERVING PROGRAM

No. 11-I, Viola Sanchez, Gold, Albuquerque Astronomical Society

FLAT GALAXIES OBSERVING PROGRAM

No. 52, Christian Weis, Gold, Tucson Amateur Astronomy Association; **No. 53-I, Ken Boquist**, Gold, Popular Astronomy Club

FOUNDATIONS OF IMAGING OBSERVING PROGRAM

No. 14, Michael Maas, Lima Astronomical Society

GALILEO OBSERVING PROGRAM

No. 104, Lloyd Watkins, Eyes Only, Cumberland Astronomical Society

GALILEO’S T.O.E.S. OBSERVING CERTIFICATE

No. 12, Eric Edwards, Lifetime Member

GLOBULAR CLUSTER OBSERVING PROGRAM

No. 429, Ronald Birkhoff, Houston Astronomical Society; **No. 430, Katrina DeWitt**, Northeast Wisconsin Stargazers; **No. 431, Craig W. Lamison**, Houston Astronomical Society

HERSCHEL 400 OBSERVING PROGRAM

No. 680, David Stokes, Northern Virginia Astronomy Club

HERSCHEL SOCIETY AWARDS

Wayne E. Frey, Silver, St. Petersburg Astronomy Club; **Lauren Rogers**, Silver, Escambia Amateur Astronomers Association; **Mark Bailey**, Silver, Member-at-Large

HERSCHEL II OBSERVING PROGRAM

No. 135-I, Wayne E. Frey, St. Petersburg Astronomy Club

HYDROGEN ALPHA SOLAR OBSERVING PROGRAM

No. 98, Doug Lively, Raleigh Astronomy Club; **No. 99, Sydney Furman**, Raleigh Astronomy Club; **No. 100, David Princehorn**, Albuquerque Astronomical Society; **No. 101-I, Russell F. Pinizzotto**, Southern Maine Astronomers

IMAGING – MESSIER OBSERVING PROGRAM

No. 37, Asher Cicco, Tallahassee Astronomical Society

LOCAL GALAXY GROUP & NEIGHBORHOOD OBSERVING PROGRAM

No. 74, Kevin Nasal, Minnesota Astronomical Society; **No. 75, Edgar G. Fischer**, Albuquerque Astronomical Society

LUNAR EVOLUTION OBSERVING PROGRAM

No. 46, John W. Bierman, Regular, Miami Valley Astronomical Society; **No. 47, Andrew Hall**, Regular, Member-at-Large; **No. 48-I, Mitchell Christopher**, Imaging, Bear Valley Springs Astronomy Club; **No. 49, Gustavo Gomez**, Regular, Tucson Amateur Astronomy Association

LUNAR OBSERVING PROGRAM

No. 1287, Eric Askea, Regular & Binocular, Ancient City Astronomy Club; **No. 1288, Chris Koers**, Regular, Binocular & Eyes Only, San Antonio League of Sidewalk Astronomers; **No. 1289, Cindy LaRussa**, Eyes Only, Huachuca Astronomy Club

MESSIER OBSERVING PROGRAM

No. 2954, Dean Adams, Gold, Vermont Astronomical Society; **No. 2955, Nick Kintzel**, Silver, Warsaw Astronomical Society

METEOR OBSERVING PROGRAM

No. 85, Gustavo Gomez, Gold, Tucson Amateur Astronomy Association

NEO OBSERVING PROGRAM

No. 38, Tom Holman, Intermediate, Minnesota Astronomical Society

OPEN CLUSTER OBSERVING PROGRAM

No. 141, Peter Natscher, Member-at-Large

OUTREACH PROGRAM

No. 1172, Russell F. Pinizzotto, Gold, Southern Maine Astronomers; **No. 1191, David Wickholm**, Silver, San Antonio Astronomical Association; **No. 1445, Mathurin Poteau**, Silver, Fort Bend Astronomy Club; **No. 1552, Matthew Peters**, Silver, Alachua Astronomy Club; **No. 1568, Brittney Miller**, Silver, Atlanta Astronomy Club; **No. 1062, Gregory T. Shanos**, Silver, Gold, St. Petersburg Astronomy Club; **No. 1726, Mark Graybill**, Bronze, Silver, Gold, The Villages Astronomy Club; **No. 1727, Toni Graybill**, Bronze, Silver, Gold, The Villages Astronomy Club; **No. 1728, Paul DeVoe**, Bronze, Member-at-Large; **No. 1729, Michael Atkinson**, Outreach, Stellar, New Hampshire Astronomical Society; **No. 1730, Ronald Rosenwald**, Bronze, Fort Bend Astronomy Club; **No. 1731, Mike Howard**, Bronze, Fort Bend Astronomy Club; **No. 1732, Corin Marasco**, Bronze, Fort Bend Astronomy Club; **No. 1733, Tom Spano**, Bronze, St. Petersburg Astronomy Club; **No. 1734, Jim Hunter**, Bronze, St. Petersburg Astronomy Club; **No. 1735, Shirley Vuille**, Bronze, St. Petersburg Astronomy Club; **No. 1736, Craig R. Henry**, Bronze, The Villages Astronomy Club; **No. 1737, Debbie Daniels**, Bronze, St. Petersburg Astronomy Club; **No. 1738, Gary Daniels**, Bronze, St. Petersburg Astronomy Club; **No. 1739, Guy Earle**, Bronze, St. Petersburg Astronomy Club; **No. 1740, Coy Wagoner**, Bronze, Baton Rouge Astronomical Society; **No.**

ALCON 2026 is being hosted by the Cincinnati Astronomical Society, one of the nation’s oldest and largest amateur societies.

A wide variety of events are being planned, along with the annual Star-b-que, and many other fun and engaging activities.

The ALCON will be held in Covington Kentucky at the Marriott Rivercenter; a hotel that looks out across the Ohio river into downtown Cincinnati. Come visit for the entire week and join us for ALCON 2026!



1741, **Yasmin Najjar**, Bronze, Tallahassee Astronomical Society; **No. 1742, Jay McLaren**, Bronze, Silver, Rochester Astronomy Club

PLANETARY NEBULA OBSERVING PROGRAM

No. 312-M, Edgar G. Fischer, Gold, Albuquerque Astronomical Society

RADIO ASTRONOMY OBSERVING PROGRAM

No. 23, Dale Nichols, Gold, Spokane Astronomical Society; **No. 37, Peter K. Dettlerline**, Silver, Member-at-Large

SKETCHING OBSERVING PROGRAM

No. 76, Mohammad Adnan Asif, Raleigh Astronomy Club; **No. 77, John Jardine Goss**, Roanoke Valley Astronomical Society; **No. 78, Steve Boerner**, Member-at-Large

SKY PUPPY OBSERVING PROGRAM

No. 111, Ellie Bourgeois, Baton Rouge Astronomical Society; **No. 112, Emile Bourgeois**, Baton Rouge Astronomical Society; **No. 113, Korah Barry**, River Bend Astronomy Club

SOLAR NEIGHBORHOOD OBSERVING PROGRAM

No. 51, Lloyd Watkins, Eyes Only, Cumberland Astronomical Society; **No. 52, Karl A. Shultz**, Regular, Central Arkansas Astronomical Society; **No. 53, Lloyd Watkins**, Binocular, Cumberland Astronomical Society; **No. 54, Jill Sinkwich**, Eyes Only, Member-at-Large; **No. 55, Jill Sinkwich**, Binocular, Member-at-Large; **No. 56, Eric Hanson**, Binocular, Member-at-Large

SOLAR SYSTEM OBSERVING PROGRAM

No. 256, Dana R. Bostic, Regular, Raleigh Astronomical Society; **No. 257-I, Mike Gent**, Imaging, Austin Astronomical Society

SUNSPOTTER OBSERVING PROGRAM

No. 270, Chris Klein, Amateur Observers Society of New York; **No. 271, Simon Lowther**, Member-at-Large

URBAN OBSERVING PROGRAM

No. 259, Ralph McConnell, Barnard Astronomical Society; **No. 260, Carlton Haywood**, Albuquerque Astronomical Society; **No. 261, Ryan Weiss**, Lifetime Member

MASTER OBSERVER PROGRESSION

OBSERVER AWARD

Dana R. Bostic, Raleigh Astronomy Club; **Mohammad Adnan Asif**, Raleigh Astronomy Club; **Bob Vickers**, West Kentucky Amateur Astronomers

MASTER OBSERVER AWARD

No. 277, Christian Weis, Tucson Amateur Astronomy Association

MASTER OBSERVER – SILVER AWARD

Edgar G. Fischer, Albuquerque Astronomical Society; **Steve Boerner**, Member-at-Large

MASTER OBSERVER – GOLD AWARD

Steve Boerner, Member-at-Large



100 Years of Stellafane Conventions

August 13-16, 2026

The ORIGINAL STAR PARTY, in Springfield VT

Dark sky observing

Workshops and presentations on astronomy

Telescope making demos and talks

Competition for mechanical and optical excellence

Film Premiere of “Stellafane and Beyond”



2026 HARTNESS HOUSE WORKSHOP – August 13, 2026

ECLECTIC ASTRONOMY V - A day-long, series of quality astronomical presentations in the historic inn, site of the Hartness Turret Telescope

Registration starts May 1

stellafane.org/convention/2026

Astronomical League Membership-at-Large Program

What does the League offer you as Members-at-Large?

- A subscription to the *Reflector*.
- Full voting privileges at AL meetings.
- Optional subscriptions at discounted rates to the following publications:
 - Astronomy* magazine \$34.00; 2 years \$60, *StarDate* magazine \$19.50,
 - Sky & Telescope* magazine \$32.95. Foreign rates are higher, see web store.
- Big discounts on the annual RASC Observer's Handbook and Calendar.



To join the Astronomical League as a Member-at-Large, send a check for \$48.00 USA addresses, \$60.00 for all other countries, made payable to the Astronomical League, to:

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

Phone: 816-333-7759; Email: leagueoffice@astroleague.org

Or join online at: <https://store.astroleague.org>

Travel the World. Explore the universe.

Sky & Telescope is a world leader in astronomy-themed travel.

Join one of these exciting tours before it sells out!

Finland's Northern Lights

See shimmering auroras dancing overhead from the comfort of a private glassed-in cabin

November 6–13, 2026

SKY & TELESCOPE

Kakslauttanan Arctic Resort, Lapland, Finland



Canary Islands Astronomy & Stargazing

September 6–13, 2026



Patagonia Annular Eclipse & Sightseeing

February 2–10, 2027



Galapagos Annular Eclipse & Sightseeing

Jan. 22 – Feb. 1, 2028



... and others await you!
Scan the code, or go to:
skyandtelescope.org/tours



Kevin Rasso (Middle Georgia Astronomical Society) captured this image of the NGC 1333 – The Embryo Nebula from his backyard in Perry, Georgia with a Stellarvue SVX140T refractor and a Player One Poseidon-M Pro camera.



M.J. Post (Longmont Astronomical Society) captured this image of IC 446 using a PlaneWave CDK14 and a ZWO ASI 6200MC camera from his DSNM observatory in Animas, New Mexico.



Top: Bernard Miller (East Valley Astronomy Club) captured this image of NGC 1977 with a PlaneWave 17" CDK with and a FLI 16803 CCD camera from his observatory in Animas, New Mexico.

Bottom: Gregg Ruppel (Tucson Amateur Astronomy Association) captured this image of Abell 31 from his remote observatory at DSNM in Animas, New Mexico with an ASA 10N f/3.8 Astrograph with a SBIG STL-11000M CCD camera.

Step into the
Darkness
with us.

NEBRASKA STAR PARTY
JULY 12~17, 2026
MERRITT RESERVOIR

NEBRASKASTARPARTY.ORG

Photo ©2022 Matthew Bielski

Registration is Open for

The Nation's Premiere
Amateur Astronomy Conference

ALCON
2026
C I N C I N N A T I

Learn More and Register at
ALCON2026.ORG

- **Nationally Recognized and Regional Astronomy Speakers**
- Happy Hours
- Special Events
- Tours
- Astrophotography Contest
- **The Annual StarBQ at The Cincinnati Museum Center**
- **The Sunday Afterparty at The Moeller Observatory**

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

NON-PROFIT
ORGANIZATION
U.S. POSTAGE
PAID
St. Joseph, MI
Permit #335



BRING THE UNIVERSE TO YOUR BACKYARD

Discover the night sky with the power of your smartphone and patented Celestron tech



StarSense Explorer
Telescopes

A manual telescope and companion app join forces to help you find any object in the night sky. Dock your phone, launch the app, and follow the onscreen arrows to your desired target with bullseye accuracy!



NexStar Evolution WiFi
Computerized Telescopes

We've leveled-up our signature GoTo Schmidt-Cassegrain telescope with WiFi for wireless smartphone control. Tap on a target in the SkyPortal app—your Evolution places it in the eyepiece and begins tracking automatically.



Celestron Origin Mark II
Intelligent Home Observatory

Our unique, all-in-one astroimaging system captures and processes stunning views of faint, deep-sky objects and delivers them to your phone or tablet in seconds. Origin's images look better than what you'd see with a much larger telescope under much darker skies.

EVERY CELESTRON APP IS POWERED BY SKYSAFARI™

DISCOVER MORE AT celestron.com