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Reflector

HOW TO DO PLANETARY IMAGING WITH A DOB AND AN INEXPENSIVE CAMERA

AN AMATEUR-BUILT CORONAGRAPH IMAGES THE SOLAR CORONA

QUASARS THAT VARY AND WHAT ASTRONOMERS ARE LEARNING FROM THEM

ASTRONOMICAL LEAGUE

ASTRONOMICAL SOCIETY OF KANSAS CITY ALCON 2024

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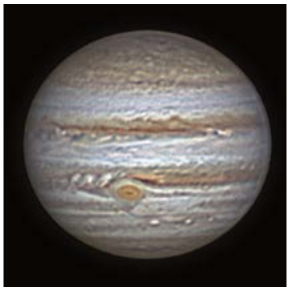

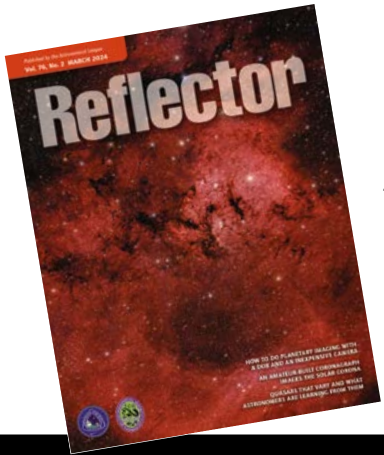

Matt Theissen and Joe Ziha (Astronomical Society of Eastern Missouri) captured this image of NGC 7822 using a William Optics FLT91 with a ZWO ASI 2600MC camera from their remote setup at Dark Sky New Mexico.

The Astronomical League Magazine

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Reflector

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

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

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Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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***REFLECTOR* AND CLUB ROSTER DEADLINES**

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

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

To The Editor

I refer to "The Sun Funnel" on page 16 of the December 2023 *Reflector*. Although the funnel may be a novel way of looking at a solar eclipse, there is a way that is even simpler and safer. The easier way is to remove the funnel and rotate the telescope so that the real image of the Sun is cast upon the ground below. It's best to have a bright imaging surface like a white driveway or white cardboard. Depending on the focal length of the eyepiece used for projection, the solar image will vary in size and brilliance. I have used this method for eclipse observations over many decades. During such projection there is no chance that solar rays will enter the eye. It also works well for sharing the image with others in the neighborhood.

—David A. Cornell
Boise, Idaho

Being an amateur astronomer, I think of the heavenly bodies that I see through my telescope's eyepiece and the wonders of the Universe. Here is a little story about the astronomical afterlife and what it may be like.

A Little Part of Heaven

There is a large round table around which were placed many chairs. Seated at the table are numerous former scientists including many astronomers. Mixed between them are many amateur astronomers. At this table, there is no distinction between the "famed" professional astronomer and the amateur. Each adds a piece of the puzzle to their profession or hobby and each is as important as is the other.

One member, Nicolaus Copernicus, holds up a model of the Solar System and, while pointing to the Sun, remarks, "I told you so."

Another, Galileo Galilei, while raising his hands above his head, says, "How could I have mistaken Neptune for a star?"

A few seats to the right, Johann Galle and Louis d 'Arrest look at Galileo and say, "We don't know, but we are sure glad that you did."

"Hey, wait a minute; not without my help," adds Urbain Le Verrier.

Clyde Tombaugh, who is seated nearby ponders aloud, "Well, at least you have a planet to your credit. They re-classified mine."

Sir Isaac Newton, who is also seated at the table, rests his hands on it and says in a humorous manner, "I gave them gravity and now they want dark energy."

Smiling at him, Albert Einstein agrees and adds "You would think that my gift of relativity would be easily perceived, but it took them so long to understand it."

These were all friendly discussions at a joyous gathering. However, everyone, including the amateurs who enjoyed the skies just as a friendly hobby, all agreed on one aspect: they all said, "All of the answers to the questions of the Universe that frustrated us so much throughout the ages were so simple. Why did we make everything so complicated? If only we had put 2 plus 2 together to make 4, rather than trying to make it 3 or 5." When you next observe the heavens, through whichever eyepiece you choose, think of those who have gone before us, because they are now looking at the same heavenly objects as we are, only from the other side of the Universe. I wonder what they see?

— Tom Rusek
Harford County Astronomical Society in Bel Air, Maryland

Editor's Corner

Hopefully 2024 has treated you well so far, and you are excited for the April 8 eclipse. Please send pictures of the eclipse to our photo editor, Dan Crowson, at *photoeditor@astroleague.org*, and personal stories to me at *larsen@ccsu.edu*.

As noted in our December 2023 issue, we are making some changes in the *Reflector*, some of which were already in place in that issue. In this issue, we introduce our streamlined Dark Sky Corner, as well as the adoption of standardized formatting in citations and references in our articles. Hopefully this will allow our authors to easily and consistently give credit to the information they are sharing with us and make it easier for our readers to delve more deeply into particular topics that interest them. Prospective authors should follow the guidelines in our new *Reflector* Author Guide, available at *www.astroleague.org/ReflectorAuthorGuide*. Doing so will streamline the editing and layout process, and help us bring our readers the very best magazine we can.

See you all on the other side of the solar eclipse!

—Kris Larsen
Reflector *Editor*

Dues Rates

TO OUR VALUED SOCIETIES:

Astronomical League society membership dues are increasing. While we know that a dues increase is a topic no one wants to discuss, it has been an extremely long 18 years since dues were last increased in 2006.

The costs of operating the League have increased substantially in that time. Observing Programs and publications, award programs, website improvements, the Library Telescope program, office space, insurance, and contractor costs have all increased. Printing, paper, and postage have more than doubled. The U.S. Inflation Calculator shows that over the last 18 years, the overall average cost of goods and services has increased 51 percent. The increase in AL dues falls far below this inflation rate.

The League has always strived to provide big value for limited cost to its members. We have a vast array of observing programs, youth and national awards, the Library Telescope program, website improvements, and many other programs to support our members. Even though the costs of operating these programs have gone up, the new dues rates are still very low compared to just about anything else you can get! The Astronomical League strives to bring all its members a value far in excess of our low dues rates.

The new dues rates for clubs starting with the 2024–2025 membership year will be as follows: The flat club fee of $10 per club per year is unchanged. The per-member rate for clubs that have all members participating in the AL will be $6 per member per year. The per-member rate for those clubs that have less than 95 percent of their members participating in the AL will be $9 per member per year.

— Mitch Glaze
Astronomical League Office Manager

This issue contains a call for candidates for the three AL executive committee positions that are up for election this year. They are president, vice president and treasurer.

Just a few weeks after this March 2024 issue of the *Reflector* is published, the April 8 total solar eclipse takes center stage. Please make a special effort to enjoy this event. May we all have open skies for the event!

—Carroll Iorg
President

Star Beams

Happy 2024 to everyone! I trust that Christmas brought you a few new Astronomical toys.

Planning for ALCon 2024, the annual convention of the Astronomical League, is in full swing. The event will be held July 17–20 in Kansas City. The venue is the Overland Park Doubletree Hotel. Several side trips are in the offing, including Gottlieb Planetarium at Kansas City's Union Station and a trip to Linda Hall Library to hear an exciting presentation by Dr. David Levy and visit the rare book collection. Another trip is to the Overland Park Arboretum for the traditional Star-B-Que, then on to the Astronomical Society of Kansas City's Powell Observatory.

A wide variety of other speakers are featured, including Dr. Stephon Alexander as the banquet speaker. Also, a jazz band is planned for the banquet.

For the past several years, a *What's Up with the Astronomical League* sporadic publication has been emailed to all League members with an email address on file. The purpose of this newsletter is to share time-sensitive and other information with our members. The last one was published in late December, and these publications are also posted on the AL website.

Recently, Marilyn Unruh, who retired after many years of leading the AL Book Service program, was presented with a special Astronomical League award, commemorating her fine work with that program. Thanks to Art Arnold-Roksandich, president of the Prescott Astronomy Club, for presenting the award to Marilyn on behalf of the Astronomical League!

Dark Sky Corner

The local Tucson Chapter of DarkSky International (DSI) is being reestablished and recently sent out its value statement, which I feel is superb. It clearly explains key issues with "pollution from artificial light at night (ALAN)" as well as "straightforward and cost effective" solutions. I have received permission from its author, Emilio E. Falco, PhD, to share it. According to Emilio, the chapter website is undergoing a reset, so for now the value statement can be found at *docs.google.com/document/d/1rrvOG2WRcUVIqeEHibY5ex-kZh8tbHOLIl5cYtleXEvc*. Although their website is currently under revision, it is still a valuable source of engaging information and resources. Check it out at *sa-ida.org*.

—Tim Hunter
DarkSky International

Night Sky Network

REUSE, REPURPOSE, RECYCLE THOSE SOLAR VIEWERS!

On the evening of April 8, 2024, once eclipse chasers from across the globe are finally settled in for the evening, one question will remain – what should we do with all these solar viewers? If you have a dedicated solar telescope or hard-frame solar glasses, this is an easy thing to answer: put them away and use them for another sunny day. But what about folks with "disposable" viewers? These paper glasses and viewers are being printed in the thousands for 2024, but we can all give them a second life beyond April's eclipse.

FUTURE SOLAR ECLIPSES

Parts of Greenland, Iceland, and Spain will experience a total solar eclipse on August 12, 2026. On August 2, 2027, another total solar eclipse will cross northern Africa, including Egypt and Morocco. Parts of Spain and Yemen will also experience this amazing event. To keep your solar viewers fresh, we recommend placing them in an envelope that is clearly marked. Store them in a cool, dry location so that they are ready for use in a few years. If you can keep them in a hard plastic case, even better. Your eclipse viewers should be ISO 12312-2 safety standard compliant, so if the filters aren't scratched, punctured, torn, or damaged in any other way, you may reuse them *indefinitely*.

SUNSPOTS

Occasionally sunspot groups are large enough to be seen with disposable viewers. You can monitor the Sun's activity at *www.spaceweather.com*; if there is a Jupiter-sized (or larger) group, the website will normally alert would-be viewers to try their hand at spotting the spots with eclipse viewers.

DONATIONS

If you find yourself with more solar viewers than you know what to do with, why not donate some to your local school, library, church, or an organization like Astronomers Without Borders? You can send your gently used viewers to any of these places – they would be glad to have them. Night Sky Network will have more donation programs listed on our website in the weeks after the eclipse. And although we might not have another solar eclipse in North America for some time, that doesn't mean we can't view the Sun safely during the NASA Heliophysics Big Year of 2024 (*www.nasa.gov/stem-content/heliophysics-big-year*).

GET CRAFTY

If you're like me, you *love* mementos from special events like this one. If your April 8 journey takes you to a new destination, get creative with your glasses by adding them to a shadowbox or scrap book. You can add things from your trip like a town map or an event program (if you're viewing at a venue). The sky's the limit with an activity like this!

RECYCLE

If the glasses somehow get damaged during or after the eclipse, you can still recycle the paper or plastic frames. The filters themselves are not recyclable, so these can be discarded with your standard trash. If you can find a specialty program that will accept undamaged lenses to be repurposed, be sure to send them in.

The 2024 total solar eclipse is an event that will be remembered by millions in the years to come. Be sure to celebrate responsibly!

—Kat Troche
Night Sky Network

Full STEAM Ahead

ASTRONOMICAL CAUSE AND EFFECT PART 2

Last issue we met Charles Crawford, the contractor working with city leaders and the Broken Arrow Sidewalk Astronomers (BASWA) supporting a family-friendly astronomy night for the diverse population of Muskogee, Oklahoma. When we left the story, event videos had been posted by a noted blogger. Afterwards, Charles received a call from a chamber of commerce member who accused him of altering the video to show children all playing and getting along together. In the caller's experience, students and their parents did not usually integrate as a community so naturally, instead tending to remain within their own neighborhood groups. The sky belongs to us all, and this event proved that without a doubt. A single night under the stars certainly can't erase a town's checkered history, but it does demonstrate the power of astronomy to engage us all, equally.

That August event with children looking through portable telescopes and the Mobile Observatory was a joyous atmosphere filled with wonder and excitement. In fact, the movers and shakers in the chamber of commerce all were grateful to have us there to allow students to use a telescope, many for the first time.

A month later, Charles contacted us again to join him in his new adventure of putting on a homecoming parade and event for the community, with the school superintendent closing the schools for a half-day celebration. The parade would end at the civic center, where we were asked to have our scopes up and running. Charles also added that the August blog videos (and word of mouth) had brought us to the attention of the school superintendent and several science teachers. They had contacted Charles to find out more about us, how we could meet up, and what we had to offer their students.

So, on Saturday, October 6, 2023, with slight cloud cover, solar scopes were set up along with a STEM table and then, the band, the homecoming court, and all the rest arrived *en masse* at the civic center. Immediately, lines formed around the telescopes and the chatter and excitement was overwhelming. I was running the STEM table and, before I knew it, I had a group of teachers surrounding me, all asking for astronomical help.

The high school astronomy club coordinator (a geology teacher) wanted help with the school telescope and advice on how to bring more science to his students. The two middle school science teachers had wanted similar help for their students as well. Fortunately, this city is not densely populated, so its skies are much darker than in Broken Arrow. We came up with the idea to have a school-community club, and we would have the middle and high school students come together for hands-on telescope operation lessons and observing strategies.

With the colder weather and holidays approaching, the spring semester became the target to start this program. This sizable investment in a community 45 minutes away demonstrates the love that those who do astronomy outreach have for our hobby, and our dedication to its power to lift up not only eyes, but hearts and minds. BASWA is also firming up another event at the Fite Mansion Inn and Spa for the springtime, with plans for a talk and NASA videos projected on the side of the building.

So we will continue to invest our time in Muskogee during 2024, with the school system, the community at large, and movers and shakers like our new friend Charles Crawford.

Full STEAM ahead (with hope for the future).

—Peggy Walker
Astronomical League STEAM and Jr. Activities Coordinator

Deep-Sky Objects

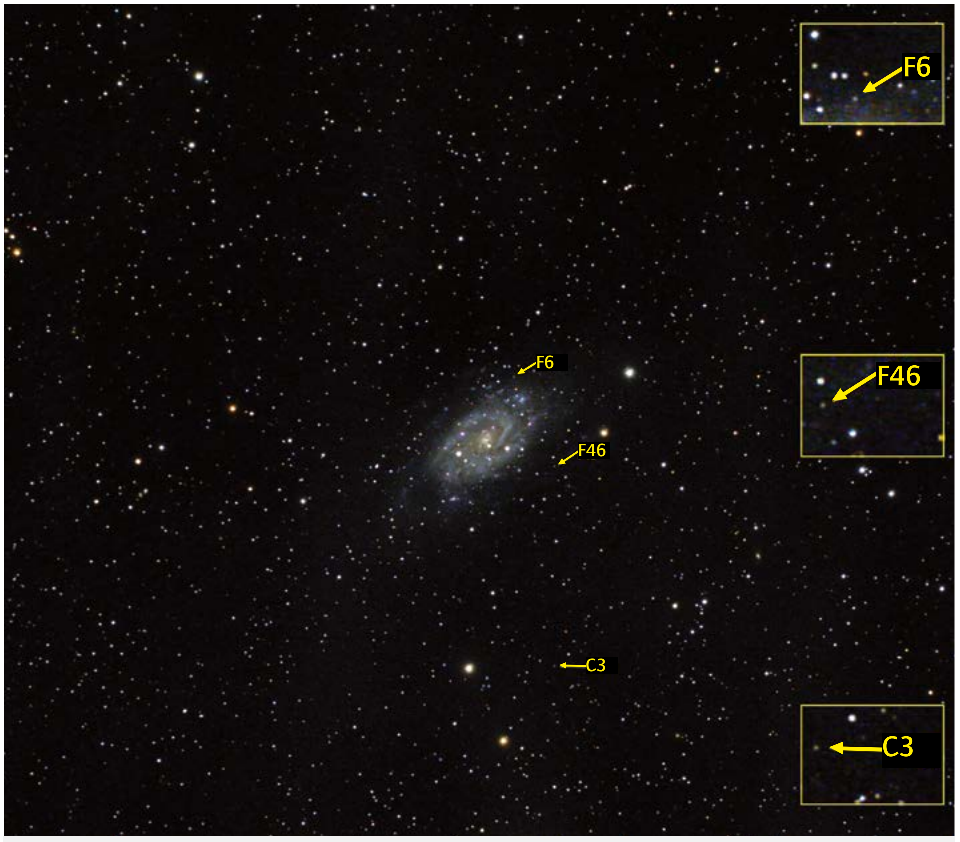
A COOL SPOT ON THE GIRAFFE

Camelopardalis (kam uh low PAR dah liss) is my favorite constellation name – it flows so nicely across the tongue. In English the word means giraffe. The constellation is near the north celestial pole, sandwiched between Cassiopeia, Ursa Major, and Ursa Minor. Camelopardalis doesn't contain really bright stars or a plethora of deep space objects. But it does have one that stands out: spiral galaxy NGC 2403, in the southeast corner of the constellation near the border with Ursa Major. This is the opposite side of Ursa Major from the handle of the Big Dipper.

William Herschel discovered NGC 2403 in 1788. It is classified as intermediate between a normal spiral galaxy and a barred spiral galaxy, with a very small galactic bulge. From our line of sight, the galaxy is tilted slightly from face-on. The galaxy has two main spiral arms near its center, each branching off into myriad fainter arms father away from the galactic center.

Magnitude estimates for the galaxy run between 8.4 and 8.9, bright enough to be seen in binoculars as well as to have its spiral nature resolved in amateur telescopes. The galaxy measures roughly 15.8 by 7.9 arcminutes and lies close to ten million light-years away. At that distance, the diameter of the galaxy would be 98,000 light-years. NGC 2403 is a distant member of the M81 galaxy group and the second brightest galaxy in the group.

NGC 2403 was the first galaxy outside of our home Milky Way where Cepheid variable stars were recognized. These variables were used in the first measurement of distance to the galaxy. Nearly 20 of NGC 2403's globular star clusters have been identified and studied. These star clusters are brighter than magnitude 20, and the galaxy



Note: Although these globular clusters are faintly but clearly visible in Dr. Dire's image file, they are tiny and may not be visible in the main image as rendered in ink on paper here. You should be able to see them in the insets.

likely contains many more fainter examples.

I captured the accompanying image of NGC 2403 with a 132 mm f/7 apochromatic refractor with a 0.8× focal reducer/field flattener using an SBIG ST-4000XCM CCD camera. The exposure was 220 minutes.

I was able to identify NGC 2403's three brightest globular star clusters in the image, all looking like extremely faint stars. I placed three small yellow arrows on the image pointing to the clusters. They are, from top to bottom, cataloged as F6 (magnitude 17.87), F46 (magnitude 17.96), and C3 (magnitude 18.66). The three boxes on the right side of the image are enlargements of the regions around the three globular clusters to make them easier to see on this page.

Capturing globular star clusters with a 132 mm refractor in a galaxy ten million light-years away is beyond anything I ever imagined when I started astrophotography. These clusters may be near the edge of detection visually in the largest amateur telescopes. Those with 6- to 10-inch telescopes will get plenty of enjoyment spying NGC 2403 and imagining if its globular clusters look as impressive to its inhabitants as M13, M22, and Omega Centauri look to us Milky Way residents

—Dr. James R. Dire

Reference:
Day, J., et al. 2020, *BAAS* 52(1), 769.

Around the League

VOLUNTEERS NEEDED

The Astronomical League needs a coordinator for one or more of our Observing Programs. If you have been working on your personal Observing Awards and are ready to volunteer as a coordinator, please send an email to Aaron Clevenson at *aaron@clevenson.org*. In mid-April we will be interviewing volunteers for the Urban Observing Program and potentially others.

CALL FOR AWARD SUBMISSIONS

Applications/nominations for all League awards must be received no later than **March 31, 2024, at 11:59 p.m. CDT** (except for Fleming and Horkheimer/Parker imaging awards which are extended to **April 30** due to the eclipse). Award rules appear on the "Awards" page at *www.astroleague.org.*

Submissions are not complete until you receive an email from the League vice president confirming receipt.

LEAGUE YOUTH AWARDS

National Young Astronomer Award – U.S. citizens or U.S. school enrollees under the age of 19 who are engaged in astronomy-related research, academic scholarship, or equipment design may apply. League membership is not required. The top two winners receive expenses-paid trips to the League's national convention (U.S. travel only) and receive Explore Scientific telescope prizes. Email the application, research paper, and a photo of the nominee to *NYAA@astroleague.org*.

Service Award – League members under the age of 19 who are engaged in service to the League, clubs, schools, and/or the astronomy community may apply for the Horkheimer/Smith Youth Service Award. Club or regional officers may nominate. The winner receives a plaque, a cash prize, and an expenses-paid trip to the League's national convention (U.S. travel only). Email the application and a photo of the nominee to *HorkheimerService@astroleague.org*.

Imaging Award – League members under the age of 19 who engage in astronomical imaging may apply for the Horkheimer/Parker Youth Imaging Award. Club or regional officers may nominate. The winner receives a plaque. The top three finishers receive cash prizes. Email the application, image, and a photo of the nominee to *HorkheimerParker@astroleague.org.*

Journalism Award – League members ages 8 to 14 may seek the Horkheimer/O'Meara Youth Journalism Award by submitting a 250-word science essay. The winner receives a plaque. The top three finishers receive cash prizes. Email the application, essay, and a photo of the nominee to *HorkheimerJournalism@astroleague.org.*

LEAGUE AWARDS

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

Mabel Sterns Award – Club officers may nominate their newsletter editor for the Mabel Sterns Award by emailing a copy of the club's newsletter as a PDF file, or by emailing a link to an online newsletter, to *sternsnewsletter@astroleague.org* along with a nomination cover letter (PDF) that includes the name, address, and photo of the nominee.

Webmaster Award – Club officers may nominate their webmaster for the Webmaster Award by emailing their club website link to *webmasteraward@astroleague.org* along with a nomination cover letter (PDF) that includes the name, address, and photo of the nominee.

Williamina Fleming Imaging Awards – These awards, sponsored by Explore Scientific, are open to female League members 19 years of age or older in four categories: Deep Sky (>500 mm excluding Solar System), Solar System (>500 mm), Rich Field (201–500 mm), and Wide Field (200 mm or less). Email the form, a photo of the entrant, and up to three JPEG attachments **not exceeding a total of 25 megabytes** to *flemingaward@astroleague.org.*

TelescopeTrader Sketching Award – Members may apply by emailing one sketch as a high-resolution JPEG file (10 megabytes maximum) along with a photo of the applicant to *Sketch@astroleague.org*. Cash prizes are awarded to the top three winners.

CALL FOR OFFICER NOMINATIONS

Nominations for League **president, vice president,** and **treasurer** for terms beginning September 1, 2024, must be received by nominating committee co-chair John Goss at *gossjohn@gmail.com* no later than **March 31, 2024, at 11:59 p.m. CDT**. The duties of each office appear in the League bylaws (see League website under "About Us"). Nominations should be accompanied by a background statement of 250 words indicating qualifications and/or reasons for seeking the position and a photo of the nominee, both for inclusion in the *Reflector* and on the ballots.

LIBRARY TELESCOPE GIVEAWAY

The League's annual Library Telescope Giveaway drawing will take place in July. The League gives away up to 11 Library Telescopes (4.5-inch StarBlast reflectors), one to a club in each of its ten regions and one to a member-at-large. Winners then place the telescopes with local libraries. This is an excellent recruitment tool for new and younger members for winning clubs. Applications may be found on the League website at *www.astroleague.org/library-telescope-program* and must be received no later than June 30, 2024.

DELAWARE ASTRONOMICAL SOCIETY BOOK CLUB

The Delaware Astronomical Society Book Club meets monthly on the last Thursday of the Month via Zoom. Guests are welcome. Zoom links are emailed in advance of the meeting. Visit *delastro.org/members/das-book-club* for more information. Upcoming events include:

March 28, 2024, 7 p.m. EDT: We will be discussing *Armageddon – 2419 A.D.*, a novella by Philip Francis Nowlan, which introduced the character Buck Rogers in the August 1928 issue of *Amazing Stories*. Nowlan's granddaughter, Diane McDevitt, will join us to discuss her grandfather's life, work, and his iconic character.

April 25, 2024, 7 p.m. EDT: Peter Bellersby will join us for a discussion of his book *The Globemakers: The Curious Story of an Ancient Craft*.

May 30, 2024, 7 p.m. EDT: Nico Carver, DAS member and dedicated deep-sky astrophotographer, will lead our discussion of *Catchers of the Light* by Stefan Hughes. *Catchers of the Light* tells the true stories of the men and women who first photographed the heavens.

LIBRARY TELESCOPE CONTEST WINNER!

As president of a Kansas astronomy club, I got involved in the Library Telescope Program in 2019 by entering the contest offered by the Astronomical League. I won a 114 mm Zhumell telescope and donated it to a local library. This was the first telescope available in Kansas at a public library for patrons to check out like a book. Fast forward to 2023, and after reaching the term limits of the office of president, I continue my journey to offer these telescopes to libraries across Kansas. There are now 35 telescopes and 22 binocular kits available at 22 library locations in Kansas supported by the Kansas Astronomical Observers. These libraries have found ways to finance the cost of their telescopes and binocular kits through donors and budget allocations. I won the telescope drawing for the third time at the 2023 ALCon meeting and donated a 4.5-inch Orion StarBlast to the Wellington Public Library in Wellington, Kansas, in November 2023.

Before placing these telescopes at these library locations, the telescopes have been modified to make them more durable and easier to use. Because these telescopes will have multiple users throughout the year, they need to be durable to go from one household to another and be ready for observing from one library patron to the next.

The 114 mm Zhumell and 4.5-inch Orion StarBlast are the suggested telescopes for the Library Telescope Program. These telescopes are similar, with minor differences such as the tube color. The added 8–24 mm zoom eyepiece gives these telescopes a magnification range of 19× to 56×. The f/4 focal ratio and compact size make them very portable and easy to set up. All you need is a moderately dark site with a sturdy table or chair – remove the dust covers, and you're ready to observe your first object.

The Wellington Public Library received the third telescope won by the Kansas Astronomical Observers. I was proud to deliver this telescope to the Wellington Library, as Wellington is my alma mater where I graduated high school, as did my father and his father before him, all my siblings, my daughter, and many of my nieces and nephews. I could go on, but you get the idea.

The Wellington Carnegie Library was built in 1916 and has a fascinating history. It is one of 63 Carnegie Libraries built in Kansas during the early 20th century, and it was listed on the National Register of Historic Places in 1987.

Wellington is the county seat of Sumner County. The small-community atmosphere makes it a great place to raise a family. As I was introducing the

Librarians Amber and Silvia

Library Telescope Program to the library director, she was interested, but hesitant to commit to the program due to funding constraints. When I offered a chance to receive a donated telescope through a contest offered by the Astronomical League, she was more open to the idea. So, I entered the contest and declared the Wellington Library the would-be recipient if I won the telescope. A year later, I delivered them their telescope. They are so excited about the telescope program, they added two binocular kits for their patrons to check out like books.

Wellington Carnegie Library

Not only does the Library Telescope Program support telescopes at libraries, they also support a binocular program. Binoculars are versatile: you can scan the cosmos by way of the Milky Way, check out the lunar surface, and even do some bird watching. The low-power, high-quality binoculars are lightweight and provide stable views.

The Library Telescope Program has gone from a national program to an international one. On the website *librarytelescope.org* you can filter by country and state to see where telescopes are distributed and possibly what astronomy club supports them. Several club members who are active with the library telescope program are members of the Library Telescope task force. The task force meets once a month via Zoom to collaborate on methods to improve the reliability and durability of these telescopes. Being a member of the Library Telescope task force also has its perks; we are able to purchase telescope and binocular items at a discount where the cost savings is passed on to the library.

Those on the task force who have 3-D printers have developed parts for the modification process or replacement parts for the 114 mm Zhumell and 4.5-inch Orion StarBlast. These 3-D files are posted on the library telescope website for anyone to download. There are short videos for library staff and their patrons on how to manage and operate the telescopes.

The Astronomical League offers a two-tier Library Telescope Observing Program. You document your time spent on the program to earn silver and gold award certificates and pins. Just submit your documented time to earn the awards.

The Library Telescope Program allows astronomy clubs to combine their skills and knowledge to support libraries and their telescopes. A few club members have volunteered their time to help modify the telescopes as needed, and a couple of us members have placed telescopes at libraries on our own as a solo operation. With the help of others, or as an individual project, this is a worthwhile program and builds a valuable network of contacts.

— Jerelyn Ramirez
Kansas Astronomical Observers

James Webb Space Telescope Shines A New Light on an Exploded Star

Image credit: NASA, ESA, CSA, STScI, Danny Milisavljevic (Purdue University), Ilse De Looze (UGent), Tea Temim (Princeton University)

Adapted from press release,
By Hannah Braun and Christine Pulliam, Space Telescope Science Institute

Cassiopeia A (Cas A) is one of the most well-studied supernova remnants in all of the Cosmos. Over the years, ground-based and space-based observatories, including NASA's Chandra X-Ray Observatory, Hubble Space Telescope, and retired Spitzer Space Telescope, have assembled a multiwavelength picture of the object's remnant.

However, astronomers have now entered a new era in the study of Cas A. In April 2023, Webb's MIRI (Mid-Infrared Instrument) started this chapter, revealing new and unexpected features within the inner shell of the supernova remnant. Many of those features are invisible in the new NIRCam (Near Infrared Camera) image, and astronomers are investigating why.

Infrared light is invisible to our eyes, so image processors and scientists translate these wavelengths of light to visible colors. In this newest image of Cas A, colors were assigned to different filters from NIRCam, and each of those colors hints at different activity occurring within the object.

The most noticeable colors in Webb's newest image are clumps represented in bright orange and light pink that make up the inner shell of the supernova remnant. Webb's razor-sharp view can detect the tiniest knots of gas, comprised of sulfur, oxygen, argon, and neon from the star itself. Embedded in this gas is a mixture of dust and molecules, which will eventually become components of new stars and planetary systems. Some filaments of debris are too tiny to be resolved by even Webb, meaning they are comparable to or less than 10 billion miles across (around 100 astronomical units). In comparison, the entirety of Cas A spans 10 light-years across, or 60 trillion miles.

"With NIRCam's resolution, we can now see how the dying star absolutely shattered when it exploded, leaving filaments akin to tiny shards of glass behind," said Danny Milisavljevic of Purdue University, who leads the research team. "It's really unbelievable after all these years studying Cas A to now resolve those details, which are providing us with transformational insight into how this star exploded."

When comparing Webb's new near-infrared view of Cas A with the mid-infrared view, its inner cavity and outermost shell are curiously devoid of color.

The outskirts of the main inner shell, which appeared as a deep orange and red in the MIRI image, now look like smoke from a campfire. This marks where the supernova blast wave is ramming into surrounding circumstellar material. The dust in the circumstellar material is too cool to be detected directly at near-infrared wavelengths, but lights up in the mid-infrared.

Researchers say the white color is light from synchrotron radiation, which is emitted across the electromagnetic spectrum, including the near-infrared. It's generated by charged particles traveling at extremely high speeds spiraling around magnetic field lines. Synchrotron radiation is also visible in the bubble-like shells in the lower half of the inner cavity.

The Cas A supernova remnant is located 11,000 light-years away in the constellation Cassiopeia. It's estimated to have exploded about 340 years ago from our point of view.

REMOTE IMAGING OF UNDER-OBSERVED VARIABLE STARS

By Brad Young

Variable star observation is one of the most versatile means astronomers use to understand the structure and behavior of stars. Spectroscopy and other techniques are important as well, but most amateurs cannot afford sophisticated equipment to study stars using spectra, radio signals, or other means. However, watching or measuring the variation of stars over a period of time in visual light or specific wavelengths can produce usable scientific data, and such data can be gathered by any amateur. Visual observing is useful and exciting, but for this article I will concentrate on photometry, which is the study of the brightness of stars in specific wavelengths of light, using imaging equipment and standard filters.

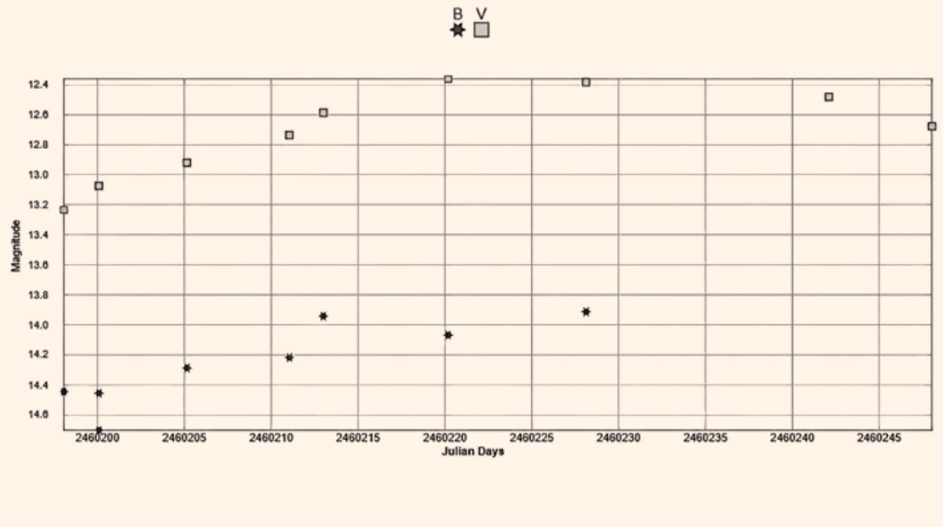


*Figure 1: AAVSO Light Curve, **KU APS**, March 1 to December 16, 2023*

The ability to choose which variables to investigate allows you to concentrate on areas you find most interesting. There are many types of variables, such as eclipsing binaries (for example, Algol) and long-period variables (for example, Mira). I chose to observe variables that are understudied due to geography – southern variables that need observation more frequently or over a broader spectrum of wavelengths. These data are used by amateurs, educators, and professional astronomers, via my reports to the AAVSO (American Association of Variable Star Observers). This organization provides valuable educational resources on how to observe variables, and once you get started, they provide continued support for your efforts.

You can upload your observations, and have your data available worldwide for use. You can receive a weekly report showing what use is made of your reports.

Observing sections for different types of variable stars concentrate on specific types of targets, list examples and current priorities, and have online forums for help and information.

You can sign up for email alerts calling for observations to support studies performed by both ground-based and space-based observatories.

As a member, you can use their photometry software Vphot.

In terms of the underserved variables I mentioned above, I am sometimes the only contributor of significant amounts of data, and this helps fill the gaps where needed.

Figure 1, above, shows an example of one of the stars I study, KU Apodis; it is observed infrequently, so all of the reported observations of it in 2023 were mine.

Figure 2, below, is an example of one of the alert targets, R Aquarii, and how we were able to determine its magnitude and periodicity. My observations are shown as crosses. The AAVSO website contains many other examples; just look at the front page of their site *(www.aavso.org)* and generate a light curve for one of the stars from the list on my website *(hafsnt.com/index.php/variable-stars)*. Visit the different observing sections on their site to see what might interest you. As a member, you can join their mailing list of alerts and use VPhot to generate reports. You don't have to be a member to report what you see *(www.aavso.org/webobs)*, but the benefits of membership go beyond access to VPhot.

It's worth noting that the Astronomical League has several observing programs that deal with variable stars, either as the entire program or part of the requirements for the program *(www.astroleague.org/alphabeticobserving)*. Many of these allow remote imaging to achieve the required observations. ✷

Brad Young is a member of the Astronomy Club of Tulsa

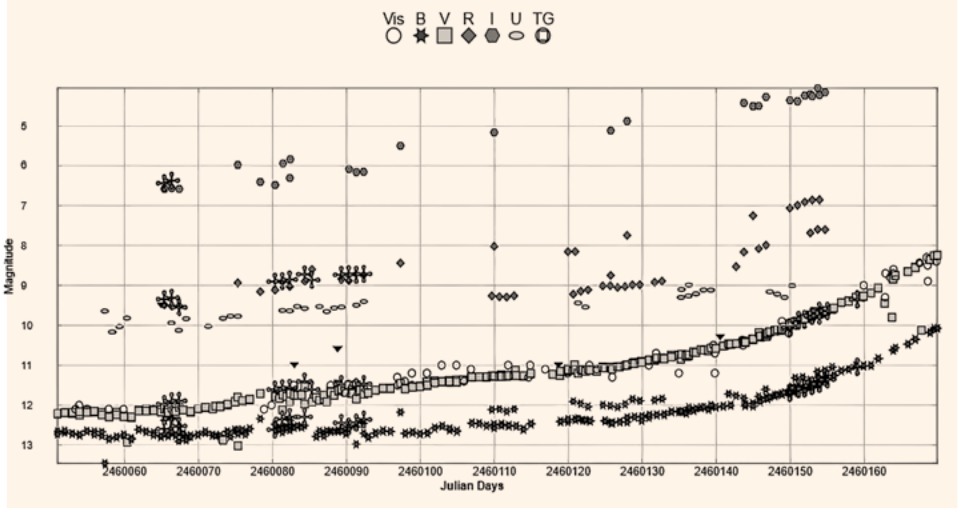


Figure 2. The key denotes filter used; several other types are supported

GALILEO: THE FIRST OPTICAL ASTRONOMER


Portrait of Galileo Galilei by Justus Sustermans, public domain (original in collection of Royal Museums Greenwich)

By Larry McHenry

A little over 400 years ago, in a time near what most historians consider to be the last days of the Renaissance, there was a period of about 150 years, from the mid 15th to late 16th centuries, that saw a transformation of scientific ideas. One major figure of that period of scientific questioning was the 16th-century Italian astronomer and mathematician Galileo Galilei (1564–1642). Galileo combined the old world of natural philosophy and mathematics with the new world of modern science, and his groundbreaking inventions and discoveries were fundamental contributions to science. He pioneered experimental scientific methods, including using a telescope, moving the science of astronomy into a new age and breaking new ground in understanding the Universe.

INVENTION OF THE TELESCOPE

The telescope traces its history back to the late 13th century in northern Italy with the invention of simple glass convex or concave magnifying lenses and spectacles to improve eyesight. But it wasn't until 1608 that Dutch inventor Jan Lippershey combined both types of lenses into an instrument called the "Dutch perspective glass" (Wilson 2017), consisting of a convex objective lens and a concave eyepiece that gave an erect image of 3× magnification. These first glasses generally had lenses of about an inch in diameter, mounted in a stiffened paper tube about a foot long with a fixed focus. Word of the new invention quickly spread across Europe, with opticians and mathematicians in major cities soon creating their own versions. These basic spyglasses were costly and only used by the military or as toys of the nobility. They were not yet true telescopes.

On a May 1609 trip to Venice, Galileo heard the news about the new optical instrument for seeing distant objects. Realizing its importance, Galileo acquired the necessary tools to grind and polish lenses himself. Galileo's efforts improved on the lenses, and he created his own perspective glass with a magnification of around 8×. Galileo's interest in making these instruments was profit: as a product to sell to the military and merchant shippers.

In autumn 1609, Galileo built larger telescopes with increasing magnifications and clarity. He produced his two finest instruments that became the first true astronomical telescopes. The larger instrument had a 1¾–inch convex objective with a 980 mm focal length in a 49-inch paper tube using a concave "eyepiece"' of 22 mm, giving a magnification of 20×. The second glass had a 1⅝–inch objective in a 37-inch-long tube and gave 14× magnification. While Galileo's improvements on the convex lens eyepiece enabled about 3 inches of eye relief, they suffered from a narrow field of view, requiring the instruments to be mounted. Galileo called his new glass instruments *perspicilla* (Panek 1998, 33), which is Latin for "instruments to look through."

Later, at a dinner held in Rome to honor Galileo in April 1611, Greek poet and mathematician Giovanni Demisiani came up with a new word for Galileo's instruments – *teleskopos,* meaning "far-seeing," based on the Greek words for far *(tele)* and to see *(skopein)* (Van Helden 1989, 114). Thus the modern word telescope was born.

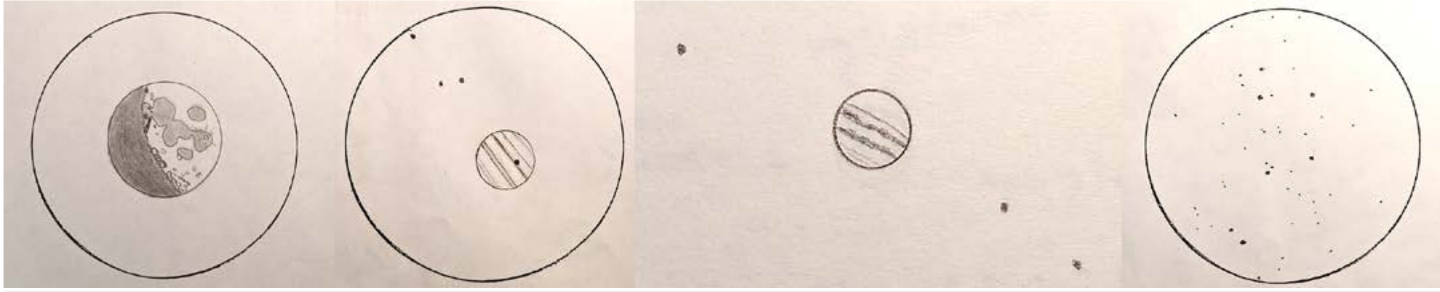
GALILEO'S OBSERVATIONS AND DISCOVERIES: 1609–1610

Although it is uncertain whether Galileo was the first person to use a telescope to observe the heavens, he was the first to document and publish his discoveries. In autumn 1609, as his skill in creating telescopes was improving, he began to turn his instruments towards the sky. On the night of November 30, having completed his 1¾–inch objective telescope, Galileo began to sketch and write down descriptions of what he observed on the Moon's surface. The first thing he noted was that the Moon did not have a smooth, celestially perfect disk as he had been taught in school. Instead, he observed mountains, valleys, and large flat plains, pockmarked with depressions that we know today are craters. For the next month, Galileo observed the Moon for hours every clear evening, following it through its phases and sketching what he saw. He then used this information to create rough topographic maps of the Moon.

Galileo then pointed his telescope at star clouds in the Milky Way. Throughout antiquity, people thought the Milky Way was clouds of smoke or some other matter. But when Galileo observed the Milky Way, his telescope resolved what looked like smoke into countless faint stars, so densely packed together that their combined starlight resembled glowing clouds to the naked eye.

Turning to the Pleiades in Taurus, Galileo found 40 additional stars fainter than the six or seven that people had counted for centuries. Also, the Belt and Sword of Orion that showed only nine stars visible to the unaided eye showed upwards of 80 stars that were not visible without the telescope.

Having finished his observations of the Moon and the "fixed stars," on the evening of January 7, 1610, Galileo turned his telescope to one of the "wandering stars," the planet Jupiter. Immediately, Galileo noticed what looked like three small stars aligned nearly parallel with the planet, two on one side and the third on the opposite. While these "stars" were not visible to the unaided eye, they were bright in his telescope. Galileo was intrigued by the view and made a descriptive note and sketch in his logbook. The following evening, he again pointed his telescope at Jupiter and was surprised to find that the three "stars" from the night before were still near Jupiter, but now in a different formation, and they had moved in the same direction of Jupiter's path through the ecliptic, not falling behind like he expected them to. When he viewed Jupiter on January 13, he was surprised to see a fourth "star"! As Galileo observed these new objects over time, he realized that their slowly changing positions around Jupiter would be impossible if they were "fixed stars." Galileo reached the only sensible conclusion, that they were moons orbiting another planet. The Earth was no longer the center of the Universe: other bodies could also be their own



The author emulates Galileo by sketching his observations. Left to right: the Moon through an 80 mm refractor; two sketches of Jupiter and its moons through an 8-inch SCT, and the Pleiades through an 8-inch Dobsonian reflector.

centers with systems of worlds in revolution around them.

Galileo realized the implications of his observations, but knew that only a few days of observations would be insufficient proof. Galileo had nearly finished writing his book's section on the Moon and his observations of the Milky Way, but fearing that his discoveries might be scooped by someone else, Galileo rushed writing the Jupiter section, adding each night's information for the next two months, up to the last few days before publication. Today, many historians consider Galileo's observations of Jupiter's moons to be his most important discovery and the crown jewel of his book.

Galileo published his 24-page pamphlet, *The Starry Messenger (Sidereus Nuncius),* in March 1610. This was the first scientific book based on astronomical observations made through a telescope. To help convince people of what he had observed, Galileo built additional telescopes and sent them along with copies of his book to prominent patrons of science throughout Europe, where he knew they would be shared with court experts who could verify his results.

RECENS HABITÆ.

Hæc eadē macula ante ſecundam quadraturam nigrioribus quibuſdam terminis circumuallata conſpicitur, qui tanquam altiſſima montium iuga ex parte Soli auerſa obſcuriores apparent, qua vero Solem reſpiciunt, lucidiores exſtāt, cuius oppoſitum in cauitatibus accidit, quarum pars Soli auerſa ſplendens apparet, obſcura vero ac vmbroſa, quæ ex parte Solis ſita eſt. Imminuta deinde luminoſa ſuperficie, cum primū tota ferme dicta macula tenebris eſt obducta, clariora montium dorſa eminenter tenebras ſcandunt. Hanc duplicem apparentiam ſequentes figuræ commonſtrant.

B

An illustration of the Moon from Sidereus Nuncius, *published in Venice, 1610. Image credit: Welcome Trust, via Wikimedia Commons, Creative Commons Attribution 4.0 International license.*

Galileo shrewdly named his newly discovered moons of Jupiter the Medicean Stars (Van Helden 1989, 34) to honor Cosimo II de' Medici, the grand duke of Tuscany. After other astronomers confirmed his observations, Galileo received a hero's welcome in Rome and secured an appointment as the duke's court astronomer in Florence.

Throughout the rest of 1610, Galileo continued making observations using his telescope. He was the first to observe the phases of Venus and the rings of Saturn (although he could not properly interpret them), and he was one of the first to view sunspots, which he published in his next book in 1613.

GALILEO'S LEGACY

Galileo and his telescopes made significant contributions to astronomy. He has been called the Father of Modern Astronomy (New Mexico Museum of Space History). The scientific revolution is said to have begun with the Copernican Sun-centered model in 1543 and concluded with Isaac Newton publishing his *Principia Mathematica* in 1687. Galileo made his groundbreaking scientific contributions during this time – he was a Renaissance Man who helped bring astronomy into the Age of Enlightenment.

I encourage everyone to get out tonight and try your hand at observing these Galilean objects and think about the man who was the first to observe them with a telescope. ✷

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

Note: The Astronomical League's Galileo Observing Program *(www.astroleague.org/galileo-observing-program)* is an excellent place to start your personal Galilean journey through the heavens.

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Improvements in Observing the Solar

Figure 1. To the best of the author's knowledge, this is the first full Solar circumference image of the Solar Corona, taken outside of an eclipse by an amateur, to be published in print. Image © 2023 by George Hripcsak.

By George Hripcsak

The solar corona outside of a solar eclipse is one of the most difficult targets for amateurs to observe, with just a handful of amateurs successfully viewing or imaging it. In a technique invented by Bernard Lyot in the 1930s, a coronagraph produces an artificial eclipse by placing an obscuring cone at the focus of a highly polished lens to block the photosphere, followed by a series of lenses, stops, and spots whose purpose is to reduce scattered light to a minimum. The corona is only about one-millionth as bright as the photosphere, so any scattered light obscures the view. Telescopes to observe solar prominences are readily available, but they are much easier to make because prominences are 100 to 1,000 times brighter than the corona. To improve the visibility of the corona, we reduce scattered light to an absolute minimum and use narrowband filters to capture emission lines from the E-corona spectrum, such as the iron XIV line at 530.3 nm.

CORONAGRAPH DESIGN

My first coronagraph was described in the March 2022 issue of the *Reflector* with images from 2021. It was a modified Baader Prominence Viewer, done with the help of Klaus Hartkorn, who in 2020 became the first amateur to view and image the corona outside of an eclipse. Since then, I have built a new coronagraph from scratch, also with Klaus's help. It reuses the 50 mm f/20 uncoated singlet objective lens with 10-5 scratch-dig (CVI Laser Optics) that I used in the first coronagraph, along with a Celestron 80 mm FirstScope optical tube and focuser with their internal baffles removed. That leads to a series of T2 tubes (Alstar Astronomical) that hold the main workings of the coronagraph. The obscuring cones are taken from the Baader instrument. The cone is followed by a 19 mm field stop, a 100 mm focal length coated doublet field lens (Newport Corporation), a 4.2 mm Lyot stop, a 0.4 mm Lyot spot, a 125 mm focal length coated doublet relay lens, and a second 125 mm coated doublet relay lens (both also Newport Corporation). Through iterative design, the scattered light was reduced beyond the prominence range to the corona range by enlisting a smaller Lyot stop (82 percent instead of the usual 85 percent), blackening with ultra-black paint, shifting the field stop, and other adjustments. This system produces an image of the area around the Sun with the photosphere blocked by the cone and with very low scattered light, and the beam is telecentric. This feeds into a pair of filters centered at 530.3 nm whose bandpasses are each 0.2 nm wide, producing a 0.12 nm overall bandpass at 20 percent transmission. The filters are kept on-band by heating them to 32 degrees Celsius in a homemade oven made from strip heaters, thermistors, and small temperature controllers. For imaging, this feeds a GSO 0.5× reducer and then a ZWO ASI1600MM Pro camera. The details of the system are available in a 4,600-word, 29-image instruction manual (Hripcsak 2023).

ALTITUDE CONSIDERATIONS

I usually image from as high an altitude as possible, having reached as high as Pikes Peak at 14,000 feet, but with most images taken from Utsayantha Mountain in New York at 3,200 feet, and some images taken at sea level. The clarity of the atmosphere is what matters, with higher altitudes having more clear days. Figure 1 shows a recent circum-solar E-corona image taken from the Black Forest Star Party in central Pennsylvania (elevation 2,300 feet) on September 16, 2023. The black circle in the middle is caused by the coronagraph's cone blocking the photosphere, and the corona can be seen all the way around the Sun in an image that looks much like a total solar eclipse. The coronal streamers and other features exactly match coronal images (21.1 nm) taken by the Solar Dynamics Observatory satellite at the same time.

The goal of Figure 2 was to see how far from first contact I could capture the Moon approaching the Sun in front of the corona

Corona and Some Unique Observations

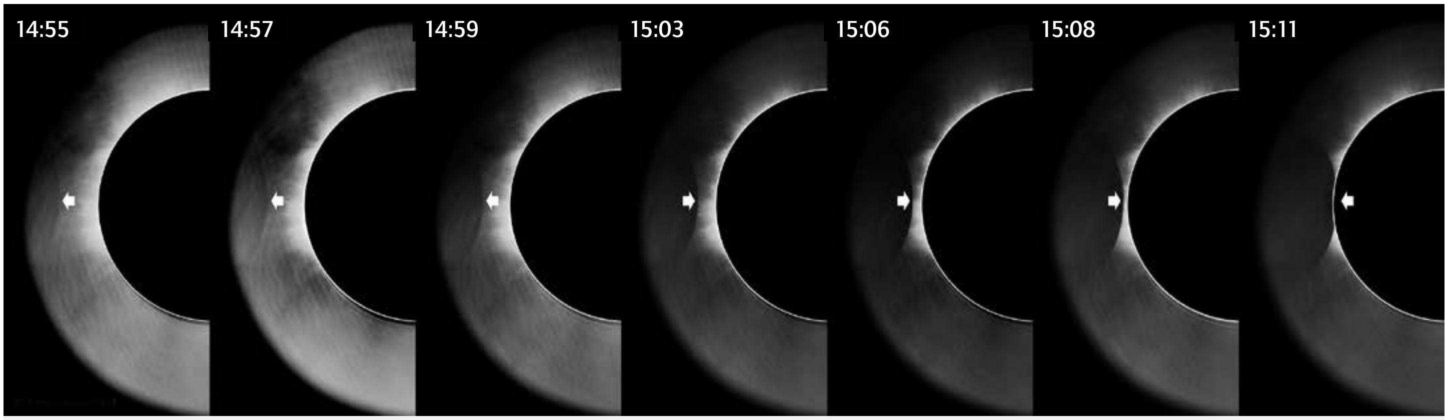

Figure 2. The arrows mark the limb of the moon as it approaches the Sun before the annular eclipse. Image © 2023 by George Hripcsak.

during the October 14, 2023, annular eclipse, from Comb Ridge in southeast Utah. The black circle in each frame is caused by the coronagraph's cone and shows the location of the photosphere; the arrows point to the Moon. The Moon can be seen faintly to the left of the Sun 15 minutes before first contact, when it was about 7 arcminutes from the Sun. All marked times are UT, and first contact was at about 15:10. This image proves that the coronagraph is not just picking up atmospheric or instrument scatter; the light blocked by the Moon has to come from beyond Earth.

FIRST KNOWN SEA-LEVEL CORONA PHOTOGRAPH

Figure 3 shows the corona behind the Empire State Building in a photo taken from West 34th Street and 12th Avenue in Manhattan on November 2, 2023. The building missed the 1925 total solar eclipse by 60 city blocks and by 6 years; this image offers it a coronal view before the next New York City total solar eclipse. The inset photo shows where on the Empire State Building the coronagraph was pointing. The black circle is caused by the cone, and the Empire State Building is seen in silhouette. The bright spot of light to the right is caused by sunlight refracted through the plate glass windows of the building's 102nd floor observation deck. Coronal streamers can be seen around the Sun. This image, which is likely the first sea-level-based non-eclipse solar corona image ever taken, demonstrates that despite the common declaration that high altitude is required, the corona is accessible broadly to amateurs with proper corona-viewing coronagraphs and that much broader use of coronagraphs – which could cost about the same as hydrogen-alpha telescopes – should be possible.

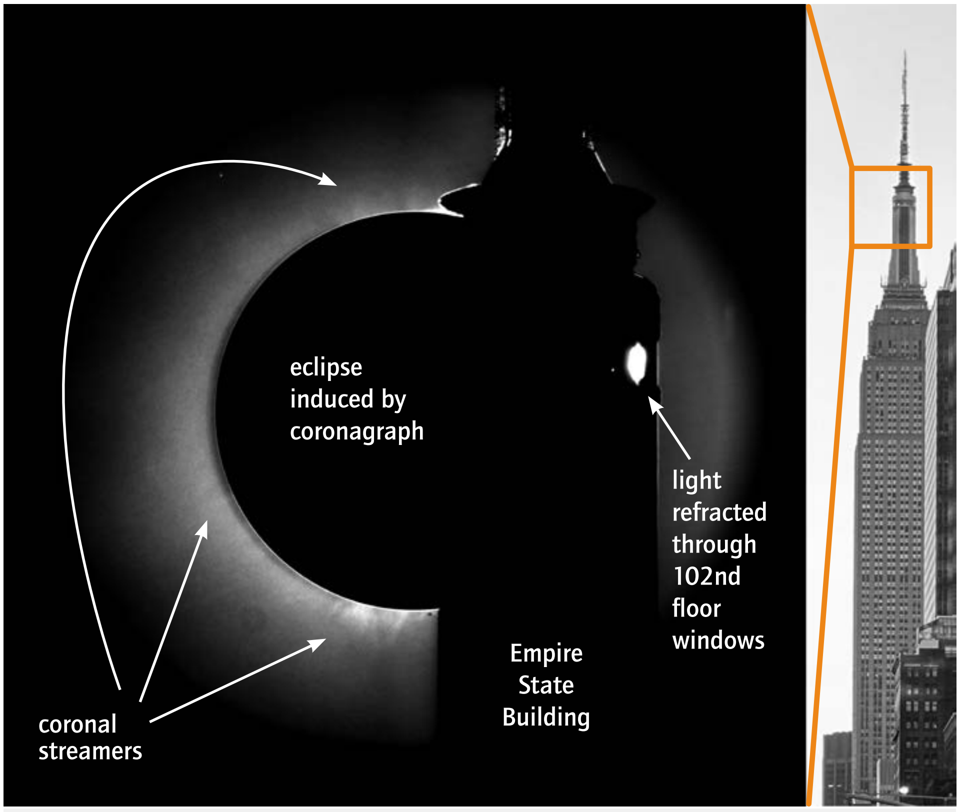

Figure 3. Corona image taken from New York City. Image © 2023 by George Hripcsak.

SAFETY

I emphasize eye safety. While my instrument is also used for viewing the corona, I only describe the setup for imaging. Visual use may require other filters and considerations. Any potential builder needs to consider all solar wavelengths from 200 nm to 2,500 nm, the size of the objective lens, the degree to which the image is magnified by the series of transfer lenses, the properties of each filter in the chain, and how to ensure that there is backup so that if one aspect fails or is accidentally forgotten, the eye is saved through another. ✷

George Hripcsak lives in New York City and is a member of the Amateur Astronomers' Association of New York.

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Photo credit: Mark Clingan

THE LITTLE OBSERVATORY THAT COULD

By Bob Kerr

Goodsell Observatory stands comfortably on the northern edge of Carleton College in Northfield, Minnesota. Confident in its stunning Romanesque architecture, the observatory is virtually unchanged since its 1891 dedication, a venerable citizen from an age when consequential changes were occurring in the science of astronomy. Goodsell was placed on the National Register of Historic Places in 1975.

Professor William Wallace Payne, circa 1890.

It's difficult to imagine how the man responsible for this observatory could have foreseen its evolution into a preeminent institution which would publish seven decades of journals embraced by astronomers worldwide, engage in early astrophysical research, breathe life into the founding of the AAVSO, publish the abstracts of the fledgling American Astronomical Society, and provide standard timekeeping services to the nation's railroads. Yet this all happened thanks to the enterprise of William Wallace Payne.

From uncertain beginnings on the prairie's edge in 1866, Carleton College now ranks sixth nationally among "best liberal arts colleges," places first nationally for its commitment to undergraduate teaching, and boasts over 120 National Science Foundation graduate fellows. Physics and astronomy is one of over 30 majors offered.

In 1871, Payne became Carleton College's fourth faculty member and chair of what would be called the Department of Mathematics and Astronomy. At age 34, Payne's eclectic credentials included a master's degree in mathematics, a law degree, time as a teacher, and a stint as superintendent of a county school district. Although captivated with astronomy since childhood, he had no formal training in the science, taking only a course here and there and, later, spending several months as an assistant at Cincinnati Observatory. But this, with his solid mathematics background, resourcefulness, and what he gleaned from books and journals, nominally qualified him to teach the concepts and practices of the "old" astronomy.

Goodsell Observatory replaced an earlier wooden structure Payne had erected shortly after introducing astronomy to Carleton. Its set of Warner and Swasey domes shelters a pair of exceptional refractors. At the rear, the smaller encloses an Alvan Clark 8.25-inch, Clark having proclaimed it one of the best he ever made (Payne 1907). The 30-foot dome safeguards a John Brashear 16.2-inch, its lens consisting of crown glass from Mantois of Paris and flint from Schott of Jena, Germany, figured by acclaimed Brashear optician Charles Hastings. The telescope's equatorial mounting and driving clock by Warner and Swasey follow their design for the Lick 36-inch (Payne 1891). A portable John Byrne

Time signals telegraph equipment. Photo by Mark Clingan.

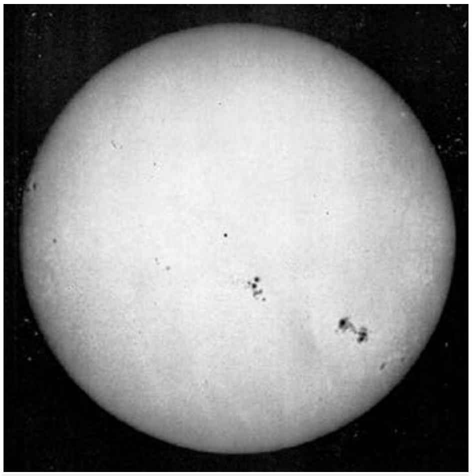
4.3-inch refractor was donated in 1996 to the American Museum of Natural History. The east wing houses a superb 5-inch Repsold and Sons meridian circle, and a 3-inch Fauth transit instrument once resided in a prime vertical room. The Clock Room contains Howard and Company sidereal time and local mean time clocks, as well as telegraph equipment for transmission of twice-daily time signals, precisely determined by the Repsold, to railroads operating over 12,000 miles of track.

Within the first decade, Payne's astronomy classes proved quite popular, but with the discipline evolving toward applying the laws of physics to the order and structure of the

8.25-inch Clark refractor. Photo by Mark Clingan.

Universe, he recognized it was time to add a qualified astrophysicist. In fall of 1887, Dr. Herbert Couper Wilson became associate professor of mathematics and astronomy. He was a Carleton graduate who had recently earned his PhD from Cincinnati University and been an associate at Cincinnati Observatory, where he worked with Mitchel's original 1845 Merz and Mahler 11-inch refractor. After receiving his doctorate, he served a year on the U. S. Naval Observatory's Venus Transit Commission.

Wilson's first priority was photographic modifications to the 8.25-inch. Clark added a correcting lens and remodeled the mount to correspond to the shortened photographic focal length. Further equipping it with a Brashear enlarging lens, Wilson possessed a telescope of extraordinary quality and embarked upon a campaign of long-exposure photography of the Milky Way. He became recognized for his photographic expertise, and in 1898 Edward Emerson Barnard, renowned for photography of galactic nebulae, favored Wilson by presenting one of his Orion Nebula photographs to the American Association for the Advancement of Science, having proclaimed it as "embracing all that has been done on this nebula by photography up to the present time" (Greene 1988, 13).

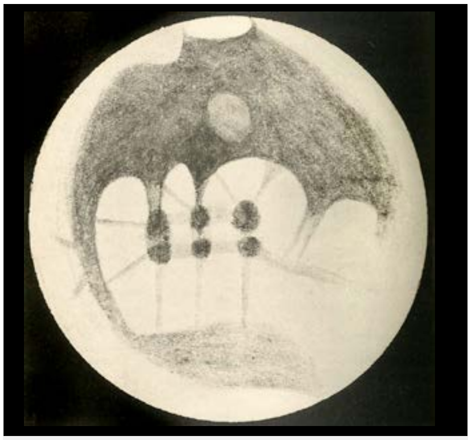


Sunspot photo taken with the 8.25-inch Clark refractor by Herbert Cooper Wilson

Wilson immersed himself in further research, including sunspot cycles and measurements of over 1,000 solar photographs; photographic study of asteroids and parallax measurements of newly discovered Eros; observation of long-period variable stars; investigation of Schiaparelli's martian canals; and directing four eclipse expeditions. His research regularly appeared in Payne's monthly journals, as well as special editions called *Publications of Goodsell Observatory.*

Meanwhile, as department head, instructor, and observatory director, Payne struggled to remain informed on developments in the field, but found timely and reliable reporting lacking. Reference books often took years to reach him and were often written unclearly. Thus, the indefatigable Payne committed himself to an undertaking destined to define his career and bring worldwide recognition to his name and that of Carleton. This initiative influenced the manner in which knowledge would be widely disseminated within the international astronomical community for decades. In March 1882, the first of what became an enduring series of journals was published as volume one of *The Sidereal Messenger.*

Ten monthly journals averaging many hundreds of pages comprised one volume with contents authored by astronomers, academics, and advanced amateurs. In addition to organizing these reports, Payne wrote non-technical articles, assembled celestial event calendars, and printed proceedings of professional associations. Payne's *Messenger* soon became the foremost regularly published astronomical reference. Later, from January 1892 through December 1894, Payne and George Ellery Hale agreed to publish a two-part journal, each following his interest, called *Astronomy and Astro-Physics*. From the outset, the enterprise suffered from incompatible subject matter and diverging priorities. As a result, Hale acquired the rights to *Astronomy and Astro-Physics,* rebranding it *The Astrophysical Journal* (Greene 1988, 14).



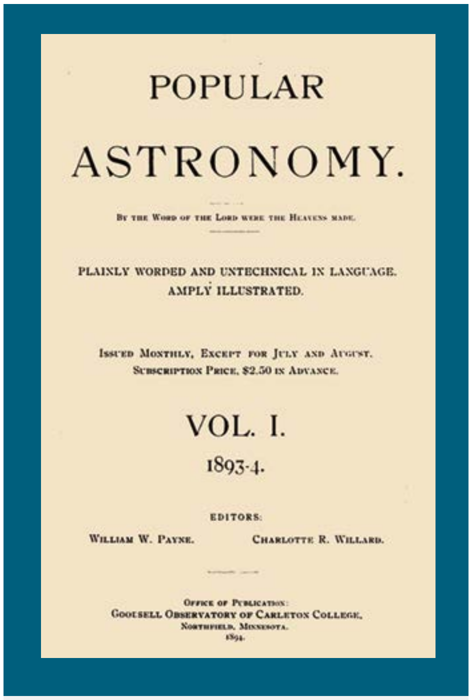
Sketch of Mars at opposition made at eyepiece of the 16.2-inch Brashear telescope in 1892 by Herbert Couper Wilson.

Payne quickly pivoted to a more comfortably titled *Popular Astronomy.* On its cover

Howard Sidereal Clock. The Repsold Meridian Circle is visible through the door at left rear. Photo by Mark Clingan.

16.2-inch Brashear refractor. Photo by Mark Clingan.

he promised "Plainly worded and largely untechnical in language... amply illustrated." Its index of authors is a who's who of prominent astronomers writing about what we recognize today as the history of astronomy. In *Popular Astronomy* volume 33 (1925), Edwin Hubble expounded on "Cepheids in Spiral Nebulae." Among frequent contributors were Edward E. Barnard, Wesley B. Burnham, Annie J. Cannon, Agnes M. Clerke, James Keeler, Percival Lowell, Edward C. Pickering, and Harlow Shapley. Circulation into the thousands reached over two dozen countries, including Australia, Germany, Japan, Brazil, China, Greece, and Egypt.



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OFFICE OF PUBLICATION:
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NORTHFIELD, MINNESOTA.
1894.

Popular Astronomy *volume I, 1893-1894*

Occasionally, editors recommended ways amateurs could put small telescopes to good use. In *Popular Astronomy* volume 19 (October 1911), Wilson, having assumed Payne's duties upon his 1909 retirement, suggested, "Can we not have in America an association of observers with a Variable Star Section? I invite correspondence on this matter." In November, a Mr. William Tyler Olcott volunteered to organize such a variable star section, and, by December, submitted his first report of 201 estimates from 15 members calling themselves the American Association of Variable Star Observers (AAVSO). Subsequently, Olcott submitted monthly accounts, and *Popular Astronomy* became AAVSO's official publication venue, with Wilson joining as a lifetime member. By 1935, annual observations reached a staggering 54,000 and total publication over half a million. Eventually, reports exceeded space available, and Wilson reluctantly transferred them to the *Publications of Harvard College Observatory*.

Herbert Couper Wilson was also a member of the American Astronomical Society (AAS) and published AAS abstracts for 28 years, essentially making *Popular Astronomy* its official publication. Excitement reigned on campus as Goodsell Observatory hosted the 34th meeting of the American Astronomical Society in 1925.

The arrival of the 20th century had found substantive transformations well underway. Forsaken were smoky, light-impaired cities, as celestial citadels rose up on California mountaintops. Reflecting mirrors marked refracting lenses for extinction. But even as astronomy lost its prominence at Carleton, fortuitously, a succession of devoted educators and scientists filled key roles.

Popular Astronomy prospered into 1951 until the sudden death of its third editor, Dr. Curvin Henry Gingrich. Lacking a replacement, and with the publication no longer a major Carleton priority, *Popular Astronomy* was discontinued. Charles Anthony Federer Jr., likely a *Popular Astronomy* reader, purchased the journal's subscriber list for his embryonic magazine, *Sky & Telescope* (Greene 1988, 21). Surely, the Fates winked when that periodical was, in turn, acquired by the American Astronomical Society. And while the legacy of Goodsell Observatory's journals may now be largely forgotten, William Wallace Payne's contribution to the worldwide advancement of astronomy remains incalculable.

In Northfield, Payne's Goodsell Observatory continues as a gateway to the glories of the heavens. It enjoys continuing use by students, and during monthly open houses visitors congregate to celebrate the night sky through

Orion Nebula photo taken in 1894 with the 8.25-inch Clark refractor by Herbert Couper Wilson.

Mr. Clark and Mr. Brashear's magnificent refractors, as well as modern Dobs and SCTs.

From the inception of Carleton College's astronomy program to its present nationally recognized, forward-leaning curricula, Carleton continues to prepare graduates for excellence in scientific leadership. And, correspondingly, Goodsell continues its role still as the little observatory that could. ✴

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Professor Emeritus, Department of Physics and Astronomy

Changing-Look Quasars

BEACONS OF STABILITY THAT AREN'T

By Dave Tosteson

There are things we think will never change. Mountains, continents, and the seasons all seem eternal, but we perceive them on human timescales. When considered on longer intervals, say hundreds of thousands to millions of years, we appreciate that rivers cut canyons, mountains dissolve, and constellations alter. The Grand Canyon was once a few inches deep, the Appalachians used to look like the Rockies, and Thuban is our once and future North Star. From studying them closely, we know all stars vary over times of minutes to years, and will eventually use up their fuel and die. Asteroids collide and disperse and even black holes and atoms decay, to leave the Universe a froth of matterless energy in the far distant future. Pulling back to times that far exceed human lives, thousands to tens of thousands of years, what do we consider stable in the night sky? Until very recently, quasars were thought to be bedrocks of stability, unable to change rapidly because of their size and the physics that powers them. Fortuity and scrutiny have shown us this, in certain cases, is simply not true.

In 1963, Maarten Schmidt unlocked the puzzle of quasars. He realized these stellar-appearing objects had spectra that were severely redshifted, placing them at great distances of billions of light-years. They could not be ordinary stars, and theories and observations eventually concluded they were active galactic nuclei (AGN) powered by black holes feeding on a disk of material swirling around them. The gravity and magnetism of these central engines produced large amounts of energy, and their collimated outflows allowed them to be seen across the Universe. The accretion disks that fed them were on parsec-scale sizes, and theory predicted it should take tens of thousands of years for significant changes to affect the whole disk, meaning their light should vary only on those time scales.

BROAD EMISSION LINE VARIABILITY

As long ago as 1971, astronomers noted that certain nearby quasars had broad emission lines (BELs) produced near the central supermassive black hole (SMBH) by rapidly orbiting ionized material that could vary by as much as 0.2 magnitudes within months to years. In 2014, Stephanie LaMassa and her colleagues found a more distant and striking example (LaMassa et al. 2015). In the Sloan Digital Sky Survey (SDSS) quasar database of over 200,000 objects, SDSS J0159+0033 was 3.45 billion light-years away and between 2000 and 2010 dimmed from magnitude 19.1 to 20.3 (v), which correlates to a loss of two-thirds of its luminosity. This quasar is located in northern Cetus, 2.3 degrees south-southwest of the vertex of the cord connecting Pisces' two fish. It hosts a 220 million solar mass black hole whose BEL region is 35 light-days across. The inner portion of its accretion disk produces X-ray and ultraviolet radiation, whose reprocessing farther out (to 100 light-days) produces its optical light. The outer portion of the central region produces narrow line emissions (called the narrow line region, NLR), as its material is moving much more slowly. Its larger size of dozens to thousands of parsecs means there is a delay in response to changes in AGN activity reflected in its emissions, as also seen in Markarian 590 and NGC 5548. The NLR is bounded at its outer edge where its AGN ionization stops. Theories of quasar variability are informed by the sequence and timing of these changes.

EXPLANATORY HYPOTHESES

Various explanations have been offered for the dimming of the quasars' light, including absorption from a patchy distribution of clouds and their movement around the galactic core. In 2016 Chelsea MacLeod (then at the University of Edinburgh) published "A Systematic Search for Changing-Look Quasars in SDSS" (MacLeod et al. 2016), and found, out of a thousand quasars that varied by at least a magnitude, a subset of ten that showed significant changes in BEL emission. Her team found not only dimming, but brightening of previously stable sources, meaning obscuration could not be the only cause. Tidal disruption of large gas clouds or stars was offered as a cause of brightening, but one object, SDSS J0025+0030, exhibited both brightening and dimming in less than one year. A new explanation was needed.

Changes in the feeding rate of the central engine was considered a root cause of these changing looks, but that information would need to be incorporated into the reprocessing within the accretion disk of the higher energy X-ray and ultraviolet photons produced near the core. The thickness of the accretion disk is thought to undergo changes, with a thinner disk being brighter. Infrared studies showed the reduction in AGN energy was mirrored at a later time in the torus that surrounds the accretion disk, but soon after this, Vincent Pelgrims of the University of Grenoble published data that showed a relative lack of polarization in the material surrounding two-thirds of the AGN (Pelgrims 2019). This suggested that dust was not the primary cause of their dimming. Ideas including a cooling front, large-scale waves, hydromagnetic winds, and microlensing were proposed to explain how information is carried outward so quickly, but new studies were culling hypotheses not compatible with fresh data.

In 2018 about one hundred changing-look/state quasars were known, with an estimate that 15 percent of quasars vary by one magnitude or more on a time scale of three to four thousand years. As more examples were found, timescales of variability as short as one or two months more tightly constrained these hypotheses. One benefit of quasar dimming is the ability to study host galaxies more closely, something difficult to do with a fully active AGN. Changes in visible light appeared to precede those in infrared, suggesting the central AGN was the source of the change. So, in this rapidly changing field of study, what we call them is having trouble keeping pace with the research. The term "changing-state" is gaining favor, but maybe "changing-name quasars" or "chasars" should apply (Graham et al. 2019).

OBSERVING THESE ELUSIVE OBJECTS

Humidity, mosquitoes, and the short nights that accompany Minnesota summers make observing a challenge, but perseverance has its rewards. The early morning of June 11, 2020, had no dew or wind and few bugs, with seeing of 7/10 and transparency of 8/10. I picked the brightest of MacLeod's ten quasars, SDSS J132457.29+480241.2 (J1324 for short), to observe. A redshift of 0.272 gives its distance at 3.2 billion light-years. It was magnitude 17.4 (pre-change), and faded by 1.27 magnitudes in their study, making it magnitude 18.7 in 2014. From Megastar and the USNO-A2.0 star catalog, I had nearby stars with magnitudes to compare. At 1:30 a.m. CDT using a 6 mm Zeiss Ortho eyepiece I spotted this dynamic quasar with some difficulty. It was much fainter than the two 14.5-magnitude stars about 2 arcminutes northeast and southeast, but brighter than the 19.2-magnitude dot 20 arcseconds north-northeast on the POSS 2 red image. It seemed a few tenths of a magnitude fainter than the 18.2-magnitude star 1.5 arcminutes northwest of it, so I estimated it at magnitude 18.5–18.6.

In 2007 I observed the fifteenth-magnitude nearly edge-on spiral galaxy IC 751 in southeastern Ursa Major with my 32-inch scope at the Texas Star Party. With averted vision it showed a bright stellar core. An article by Claudio Ricci of the Instituto de Astrofisica in Santiago, Chile, found the X-ray output of its SMBH reduced by a factor of five in less than three months (Ricci. et al. 2016), so it would be interesting to observe it again to compare its appearance. Amateurs may want to start estimating AGN magnitudes as we do variable stars; the AAVSO currently observes AGN on demand from specific researchers or as follow up to gamma ray bursts as part of the International High Energy Network (AAVSO n.d.).

In 2021, Shumpei Nagoshi of the University of Tokyo and his colleagues announced the discovery of an extreme quasar with a four-magnitude variation over thirty years (Nagoshi et al. 2021). SDSS J125809.31+351943.0 is south of Cor Caroli in Canes Venatici, and in their study varied from magnitude 17.8 to 21.3 between 1983 and 2015. On the night of July 24, I saw it as about magnitude 18.0 in my 32-inch reflector. With excellent conditions my equipment is capable to recover something as faint as LaMassa's original Sloan changing-look quasar at magnitude 20.3. Early in the morning of August 30, 2020, at 4:55 CDT using my 32-inch reflector at 542× from a 6 mm Zeiss eyepiece, I stalked this quarry (SDSS J0159+0033) for 25 minutes to get those few seconds of perfect seeing to spot it several times. It was more than a magnitude fainter than an 18.3-magnitude star one arcminute west, and I estimated it at magnitude 19.5–20.0. It's easier to find astronomical targets of a known brightness, even if they're very faint, so it's a bit unnerving to find the sky's most powerful type of object able to change so quickly. For the intrepid, variability adds a new dimension to hunting this recently recognized class of quasar. ✷

Coordinates

SDSS J1324: 13h 24m 57.29s, +48d 02m 41.2s.

SDSS J0159: 01h 59m 57.64s, +00d 33m 10.5s.

SDSS J1258: 12h 58m 09.31s, +35d 19m 43.0s.

IC 751: 11h 58m 52.4s, +42d 34m 15s.

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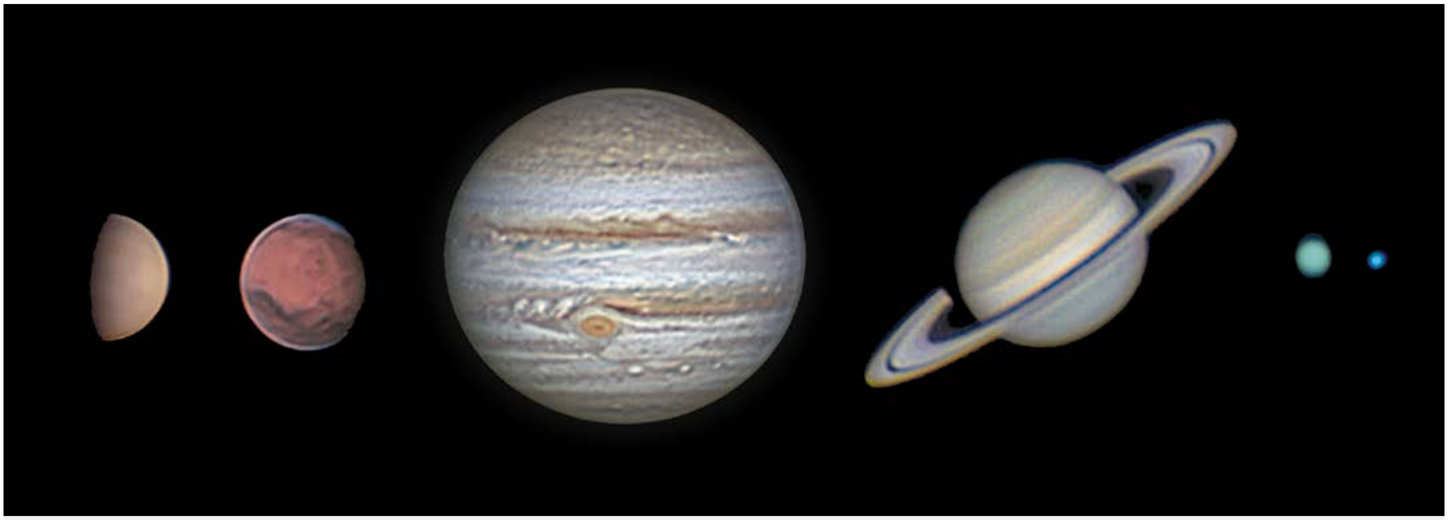

Image 1: A composite of the author's planetary astrophotography in 2023, from left to right: Venus, Mars, Jupiter, Saturn, Uranus, and Neptune

PLANETARY IMAGING WITH A DOBSONIAN

By Arravintha Sai Gobinathan

In 1668 when Isaac Newton created the Newtonian reflector, he utilized a beautifully simple design. A large parabolic mirror collects and directs light towards an angled secondary which further guides focused light into the eyepiece. Further refined by John Dobson in 1956 by incorporating the optical tube into a simple up-down-left-right mount, modern Dobsonian (Dob) reflectors have treated a new age of astronomers to spectacular views while retaining an intuitive means of control and protecting the bank. I remember being intimidated by seemingly complex equatorial-style mounts and drawn towards purchasing my first telescope: an 8-inch Orion Dob. This proved to be the gateway into a lifetime of astronomy and astrophotography.

The itch to image came early when I started with visual astronomy. Trying to drag my lazy college roommates an hour off campus to my secret spot was impractical, but I wanted to show them why I kept flaking on their invitations. After a quick internet search, I was initially dissuaded from trying to image, as many forums asserted that Dobsonian astrophotography was a terrible idea due to:

- the large optical tube acting as a sail in the wind, shaking excessively;
- untracked imaging with such a simplistic mount often amounting to little more than a fruitless exercise in patience;
- the existence of "better" alternatives;
- finicky colimation.

Although these criticisms hold weight, each can be addressed and worked around with enough patience and effort. There are certainly better planetary imaging telescopes, like an 11-inch Schmidt-Cassegrain, but these telescopes cost more than my car. The price gap between a Dob and equivalent- diameter SCT made me eager to make do with what I had. And thus began my descent into astrophotography madness.

Image 2:The author's CMOS camera, a ZWO ASI224MC with a 3× Tele Vue Barlow

THE FIRST CAPTURE

My first image was taken by holding my iPhone up to the eyepiece, an experience yielding mixed results. My images were clear enough to show Jupiter as a striped dot instead of a potato, and Saturn's rings were visible. However, quality was far less that one could see through the eyepiece and therefore did not adequately memorialize the experience. That was my initial motive – to capture images that closely mirrored reality (pun intended).

My solution came in the form of a CMOS camera which I purchased for $140 on sale. This camera slid into the eyepiece slot and directly collected light from the scope. This can be done with DSLRs or eyepiece projection, but I invested in a dedicated sensor. The size of each planet was "fixed" (I had not yet discovered Barlow lenses), but the quality was a huge step up. Image 3 (next page), a composite of Jupiter and Saturn taken with the CMOS, was one of the most satisfying images I have taken. It finally gave me images that I felt accurately represented reality, and temporarily satiated my image craving.

MOTION BLUR

Before we continue, it would be useful to acknowledge that planetary photography requires working within a tight timeframe.

Image 3: Composite of the author's first attempt at unstacked CMOS imaging

Image 4: Composite similar to image 3, taken using the same telescope, but after a year of stacking experience and technique adjustment

The planets in the sky rotate, as does our own planet. Combine these two motions and you get a limit beyond which images will blur, similar to how people or objects blur if too much motion occurs while an image is being captured. The goal of the imager is to capture as much data as possible before the final image starts showing signs of blur.

The actual limit depends on several factors, including seeing and setup that may necessitate longer videos. Flexibility is required, but with perfect seeing I can conservatively recommend my personal video length of around 45 seconds as a starting point for Jupiter and one minute for Saturn. I recommend experimentally stretching this length until rotation blur is observed. Adjusting the recording limit for each session is a skill honed with time, so consider my recommendations an experimental starting point rather than an authoritative limit.

LUCKY IMAGING

I thought I would be satisfied with image 3 – I know my wallet wishes I would have been. But I had seen images taken by SCTs in the depths of Reddit which far surpassed my own. I realized there had to be away to get images exceeding that at the eyepiece. It is at this point I was introduced to the concept of lucky imaging.

I contend a better name would be "shotgun" imaging, as the process entails taking a large number of images (either as video or a series of single frames) at short exposures to mitigate the effects of atmospheric conditions. Quality is then assigned to the frames, and you stack the best-quality frames (the "lucky" ones) to create a final image that provides better resolution than any single frame alone. Stacking is similar to the process deep-sky astrophotographers use to capture galaxies, but the process is uniquely applied, as an ideal capture involves many short exposures rather than fewer long ones. You may judge the improvement between unstacked and stacked imaging for yourself by comparing Images 3 and 4, both taken with the same equipment.

TRACKING THE TARGET

Stacking requires that the subject remains in the frame. This sounds obvious but is easier said than done, especially when working at high magnification without mechanical tracking. I spent my first year of astrophotography with an untracked 8-inch Dob, spending many a night watching Jupiter zip in and out of the frame. Initially this was a source of great frustration, but two revelations greatly improved my imaging.

The first was adopting a style of imaging suitable for untracked Dobs called the drift method. The process is simple: You line up on the planet, you take as many pictures as you can before it drifts out of frame, and then you reframe the subject and repeat until the time limit is reached. Alignment is achieved by processing before stacking. The only requirement is that the whole planet is visible somewhere on each image. This is a very forgiving technique and makes up for the lack of tracking in post-processing.

Secondly, I switched from taking individual images to recording videos. Videos are a series of pictures, and software exists to process videos as individual frames which greatly increases your frame count. In the beginning I had my right hand on the telescope and my left hand on the mouse, clicking the capture button as fast as possible. Over 45 seconds I would manage 100–200 images. Once I started recording videos over the whole time window, my luck improved. I got more comfortable and began to move the scope freehand while it was capturing images to prevent the planet from leaving the frame. This may have ruined a couple frames here or there with hand trembling, but exposures are so short that individual image quality was generally unchanged and the increased total frame count from video capture more than made up for it. My frame count finally ended up around a few thousand per minute.

My final major upgrade was purchasing an altazimuth tracking Dob (first a 10-inch and then a 12-inch). This allowed hands-free operation and enabled using a Barlow lens to boost magnification, significantly reduce drift, and enhance image quality. This relatively simple setup remains my go-to for planetary imaging and viewing.

IMAGE PROCESSING

After acquiring pictures, it's time to make them pretty. Image processing for planets generally follows three steps.

1. Alignment, where the drifting planet is

Image 5: The author's Sky-Watcher 300P Flextube Dobsonian with a ZWO ASI224MC CMOS camera

identified and centered. This cleans up your video in preparation for step 2.

2. Stacking: Quality is evaluated, and you decide what fraction of images will be combined. There is no magic number, I regularly stack anywhere from 5 to 15 percent, depending on the relative quality of my frames. I have found that larger stacks tend to be slightly lower quality but with much lower noise, while very small stacks may initially seem better but cannot survive processing without getting shredded into noise. This balance is one you will learn to titrate as needed to suit your data.

3. Sharpening, wavelet processing, and color correction: These are a few of the possible refinements that can be made at this point. This may sound complicated, but it is candidly more art than science. Wavelet processing and sharpening bring out detail but also bring out noise; color processing and final touch-ups are matters of individual preference.

The real fun lies in balancing these different considerations. Every astrophotographer will edit the same stack according to their own preferences and create unique images. I have been out hundreds of nights and the combination of your telescope, your preferences, and a planet's appearance on any given night create a unique amalgamation always worth exploring. There exists a plethora of astrophotography software for each step, much of which is free. My workflow involves using PIPP for alignment, AutoStakkert! for stacking, and AstroSurface for processing. I encourage you to try multiple different combinations and settle on one that works best for you.

Image 6: Jupiter and Io, before and after wavelet processing and sharpening

WRAPPING UP

Planetary photography with a Dob has transitioned from an ill-advised possibility to a thriving reality given the incredible software and ever-evolving technology at our disposal. There is no perfect telescope, but for those of us who prioritize owning a scope with great visual performance, there is now an opportunity to meaningfully foray into planetary astrophotography. Imaging with Dobs has surpassed my wildest expectations and in rare near-perfect conditions can rival expensive imaging rigs. I urge anyone who may hold even the slightest curiosity to take the plunge. It has been one of the most rewarding experiences of my life. ✷

Arravintha Sai Gobinathan is a member of the Alachua Astronomy Club

Note: some of the author's photo montages have been rearranged by Reflector *staff for clarity of presentation.*

Image 7: Saturn and moons. More images can be found at the author's Instagram account, @arrpeture.

Gallery

All images are ©2024 by their credited creators. Some are shown cropped.
Images are processed by *Reflector* staff for better contrast and tonal range on the printed page.

RIGHT: John Richards (Middle Georgia Astronomical Society) captured this image of IC 417 and NGC 1931 – The Spider and the Fly – using a ZWO FF107 APO Refractor with a ZWO ASI 294MM Pro camera from his observatory in Warner Robins, Georgia

BELOW: M.J. Post (Longmont Astronomical Society) captured this image of LBN 993 – the Angel Nebula - using a PlaneWave CDK14 and a ZWO ASI 6200MC camera from his DSNM observatory in Animas, New Mexico.

ABOVE: Bernard Miller (East Valley Astronomy Club) captured this six-panel mosaic image of M31 with a PlaneWave 17-inch CDK with and a FLI 16803 CCD camera from his observatory in Animas, New Mexico.

LEFT: Steven Bellavia (Amateur Observers' Society of New York) captured this image of Comet 12P/Pons-Brooks and a meteor on December 14, 2023, using a William Optics WhiteCat 51 and a ZWO ASI 183MC camera.

Observing Awards

2023 GALAXY OBSERVING CHALLENGE

Scott Cadwallader, Baton Rouge Astronomical Society; **Aaron Clevenson,** North Houston Astronomy Club; **Al Lamperti,** Delaware Valley Amateur Astronomers; **John W. Leimgruber III,** Delaware Valley Amateur Astronomers; **Ralph McConnel,** Barnard Astronomical Society of Chattanooga; **Tom Nolasco,** Delaware Valley Amateur Astronomers; **Russel F. Pinizzotto,** Southern Maine Astronomers; **Maynard Pittendreigh,** Lifetime Member

ANALEMMA OBSERVING PROGRAM

No. 22, **Robert Togni,** Central Arkansas Astronomical Society

ASTERISM OBSERVING PROGRAM

No. 76, **Jenny Stein,** Houston Astronautical Society; No. 77, **Stephen Pavela,** LaCrosse Area Astronomical Society; No. 78, **Bruce Scodova,** Richland Astronomical Society

ASTEROID OBSERVING PROGRAM

No. 73-I, Regular, **David Babb,** Member-at-Large; No. 76, Gold, **Keith Kleinstick,** Lifetime Member

BEYOND POLARIS OBSERVING PROGRAM

No. 69, **Craig A. Akins,** Richmond Astronomical Society; No. 70, **Nicole S. Andrews,** Albuquerque Astronomical Society

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. 1258, **Tim Moyer,** South Jersey Astronomy Club; No. 1259, **John Skillicorn,** Tucson Amateur Astronomy Association; No. 1260, **Gene Riggs,** Salt Lake Astronomical Society

BRIGHT NEBULA OBSERVING PROGRAM

No. 40, **Tony Edwards,** Basic, Island County Astronomical Society; No. 41, **Dave Tosteson,** Advanced, Minnesota Astronomical Society; No. 42, **Bruce Scodova,** Advanced, Richland Astronomical Society; No. 43, **Dean F. Herring,** Advanced, Raleigh Astronomy Club

CALDWELL OBSERVING PROGRAM

No. 294, **Karl A. Schultz,** Silver, Central Arkansas Astronomical Society

CARBON STAR OBSERVING PROGRAM

No. 156, **Andrew Corkill,** Lifetime Member; No. 157, **Bruce Scodova,** Richland Astronomical Society

CITIZEN SCIENCE AWARD

Al Lamperti, Delaware Valley Amateur Astronomers, Active Asteroids, Active, Gold Class 190; **Al Lamperti,** Delaware Valley Amateur Astronomers, Star Notes, Active, Gold Class 341; **Al Lamperti,** Delaware Valley Amateur Astronomers, Space Warps-DES Vision Transformer, Active, Gold Class 8; **Al Lamperti,** Delaware Valley Amateur Astronomers, Cloud Spotting on Mars, Active, Gold Class 2; **Brad Young,** Astronomy Club of Tulsa, Variable Stars, Observational, Gold Class 10 & 11

COMET OBSERVING PROGRAM

No. 138, **Viola Sanchez,** Silver, The Albuquerque Astronomical Society

CONSTELLATION HUNTER NORTHERN SKIES OBSERVING PROGRAM

No. 306, **Craig Atkins,** Richmond Astronomical Society; No. 307, **Teresa Bippert-Plymate,** Bear Valley Springs Astronomy Club; No. 308, **William Norton,** Bear Valley Springs Astronomy Club; No. 309, **Josh Kovach,** Member-at-Large; No. 310, **Hans de Moor,** Member-at-Large; No. 311; **John Zimitsch,** Minnesota Astronomical Society; No. 312, **Mary Bareau,** St. Louis Astronomical Society; No. 312; **Lisa Wentzel,** Twin City Amateur Astronomers

DARK NEBULA OBSERVING PROGRAM

No. 42-I, **Dean Herring,** Raleigh Astronomy Club

DEEP SKY BINOCULAR OBSERVING PROGRAM

No. 450, **Eric Hanson,** Member-at-Large; No. 451, **Lauren Rogers,** Escambia Amateur Astronomers Association

GLOBULAR CLUSTER OBSERVING PROGRAM

No. 400-I, **Tom Nathe,** Rose City Astronomers

HERSCHEL II OBSERVING PROGRAM

No. 127-Manual, **Bernard Venasse,** Lifetime Member

HERSCHEL 400 OBSERVING PROGRAM

No. 658, **Jonathan Cross,** Seattle Astronomical Society; No. 659, **Daniel L. Otte,** Southern Oregon Skywatchers; No. 660, **Andrew Jaffe,** New Hampshire Astronomical Society

HERSCHEL SOCIETY OBSERVING AWARD

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

IMAGING – MESSIER OBSERVING PROGRAM

No. 2, **Thomas V. Schumann,** Lifetime Member; No. 3, **Keith Kleinstick,** Lifetime Member; No. 4, **Elliot Justice,** Tucson Amateur Astronomy Association

INTERNATIONAL OBSERVE THE MOON NIGHT OBSERVING CHALLENGE

Al Ansorge, Westminster Astronomical Society; **Laurie Ansorge,** Lifetime Member; **Steve Boerner,** Member-at-Large; **Aaron Clevenson,** North Houston Astronomy Club; **Scott Cadwallader,** Baton Rouge Astronomical Society; **Daryl Everon,** Independent; **Marie Lott,** Atlanta Astronomy Club; **Lisandro Marceli,** Independent; **Douglas Slauson,** Cedar Amateur Astronomers; **Dave Wood,** Astronomical Society of Eastern Missouri

JUPITER OBSERVING PROGRAM

No. 2, **Viola Sanchez,** The Albuquerque Astronomical Society; No. 3, **Brad Young,** Astronomy Club of Tulsa; No. 4, **Brook Belay,** Atlanta Astronomy Club; No. 5, **Paul Harrington,** Member-at-Large

LIBRARY TELESCOPE AWARD

No. 31, **Mike Modrcin,** Gold, Omaha Astronomical Society

LUNAR II OBSERVING PROGRAM

No. 139, **István Mátis,** Member-at-Large

LUNAR EVOLUTION OBSERVING PROGRAM

No. 34, **Preston Pendergraft,** Member-at-Large

LUNAR OBSERVING PROGRAM

Nos. 1220 & 1220-B, **Eric Hanson,** Member-at-Large; No. 1221, **Janet McGeorge,** Stillwater Stargazers; Nos. 1222 & 1222-B, **Richard Bryant,** Bartlesville Astronomical Society; No. 1223, **Christopher Klein,** Amateur Observers' Society of New York

MESSIER OBSERVING PROGRAM

No. 2917, **Ian Wymore,** Regular, Denver Astronomical Society; No. 2918, **Tom Landvatter,** Honorary, Rose City Astronomers; No. 2919, **Stephen J. Nugent,** Honorary, Member-at-Large; No. 2920, **John Zimitsch,** Honorary, Minnesota Astronomical Society; No. 2921, **Mike McCabe,** Honorary, South Shore Astronomical Society; No. 2922, **Stephen Koehler,** Regular, Minnesota Astronomical Society; No. 2923, **Jonathan Lawton,** Honorary, The Astronomy Connection

METEOR OBSERVING PROGRAM

No. 80, **István Mátis,** Honorary, Member-at-Large; No. 81, **Dave Tosteson,** Honorary, Minnesota Astronomical Society; No. 82, **Mike Phelps,** Honorary, Atlanta Astronomy Club; No. 202, **Lauren Rogers,** 24 hours, Escambia Amateur Astronomers Association

OPEN CLUSTERS OBSERVING PROGRAM

No. 119-I, **Alan Sheidler,** Popular Astronomy Club

OUTREACH AWARD

No. 180, **Richard Meredith,** Master, Kansas Astronomical Observers; No. 182, **Paul Ramirez,** Stellar, Master, Kansas Astronomical Observers; No. 1221, **John Zimitsch,** Stellar, Minnesota Astronomical Society; No. 1298, **Jason Christian,** Stellar, Cincinnati Astronomical Society; No. 1311, **Carolyn Mirich,** Stellar, Western Montana Astronomical Association; No. 1316, **Todd Dunnavant,** Master, Fort Bend Astronomy Club; No. 1411, **Kevin A. Wilson,** Outreach, Member-at-Large; No. 1412, **Craig A. Akins,** Outreach, Richmond Astronomical Society; No. 1413, **Dennis Latinette,** Outreach, River Bend Astronomy Club; No. 1414, **Kyle Penning,** Outreach, Ancient City Astronomy Club; No. 1415, **John Reed,** Outreach, Pocatello Astronomical Society; No. 1416, **Kasey Davis,** Outreach, Pocatello Astronomical Society; No. 1417, **Pearlie Harris,** Outreach, Northeast Florida Astronomical Society; No. 1418, **Austin Kuecher,** Outreach, Omaha Astronomical Society; No. 1419, **John Bierens,** Outreach, Stellar, Kansas Astronomical Observers; No. 1420, **Joe Birzer,** Outreach, Kansas Astronomical Observers; No. 1421, **John Campbell,** Outreach, Kansas Astronomical Observers; No. 1422, **Tim Hall,** Outreach, Kansas Astronomical Observers; No. 1423, **Dave Headley,** Outreach, Kansas Astronomical Observers; No. 1424, **Chris Ketron,** Outreach, Stellar, Kansas Astronomical Observers; No. 1425, **Chris Lamer,** Outreach, Stellar, Kansas Astronomical Observers; No. 1426, **Ron Mallory,** Outreach, Kansas Astronomical Observers;

No. 1427, **Brent Neas,** Outreach, Stellar, Kansas Astronomical Observers; No. 1428, **Phil Osborn,** Outreach, Stellar, Kansas Astronomical Observers; No. 1429, **Charles Rivera,** Outreach, Kansas Astronomical Observers; No. 1430, **Dennis Stout,** Outreach, Kansas Astronomical Observers; No. 1431, **Mandy May Stout,** Outreach, Kansas Astronomical Observers; No. 1432, **Don Adams,** Outreach, Houston Astronomical Society

PLANETARY NEBULA OBSERVING PROGRAM

No. 25-I, **Peter K. Detterline,** Advanced, Member-at-Large; No. 48, **Jonathan D. Scheetz II,** Basic, Back Bay Amateur Astronomers

RADIO ASTRONOMY OBSERVING PROGRAM

No. 18, **Dave Lacko,** Gold, Member-at-Large

SKETCHING OBSERVING PROGRAM

No. 64, **Keri Thompson,** Island County Astronomical Society; No. 65, **Paul Runkle,** Chapel Hill Astronomical and Observational Society

SOLAR ECLIPSE OBSERVING CHALLENGE – ANNULAR ECLIPSE 2023

Aaron Clevenson, Gold, North Houston Astronomy Club; **Brad Young,** Gold, Astronomy Club of Tulsa; **Laurie Ansorge,** Silver, Lifetime Member; **Jim Barbasso,** Silver, North Houston Astronomy Club; **Larry Bloom,** Silver, Longmont Astronomical Society; **Keith Brandt,** Silver, Houston Astronomical Society; **Scott Cadwallader,** Silver, Baton Rouge Astronomical Society; **Aaron Clevenson,** Silver, North Houston Astronomy Club; **Andrew Corkill,** Silver, Lifetime Member; **Aleta Cox,** Silver, Salt Lake Astronomical Society; **Stanley Davis,** Silver, Oklahoma City Astronomy Club; **Darcy Howard,** Silver, Central Arkansas Astronomical Society; **Rex Kindell,** Silver, Stillwater Stargazers; **Emily Kindell,** Silver, Stillwater Stargazers; **Herman Krug,** Silver, Lackawanna Astronomical Society; **Joseph Kubal,** Silver, Naperville Astronomical Association; **Bridget Langdale,** Silver, Hill Country Astronomers; **Krista Lemoine,** Silver, Salt Lake Astronomical Society; **John Lines,** Silver, Northern Colorado Astronomical Society; **Maynard Pittendreigh,** Silver, Lifetime Member; **Dennis Piwowar,** Silver, Independent; **Rob Ratkowski,** Silver, Haleakala Amateur Astronomers; **Alan Spurgeon,** Silver, Seattle Astronomical Society; **Debra Wagner,** Silver, Member-at-Large; **Lloyd Watkins,** Silver, Cumberland Astronomical Society; **Brad Young,** Silver, Astronomy Club of Tulsa

SOLAR NEIGHBORHOOD OBSERVING PROGRAM

No. 15, **David Whalen,** Eyes Only, Atlanta Astronomy Club; No. 16, **Larry Bloom,** Eyes Only, Longmont Astronomical Society; No. 17, **Marie Lott,** Binocular, Atlanta Astronomy Club; No. 18, **Stephen Pavela,** Binocular, La Crosse Area Astronomical Society; No. 9, **David Whalen,** Telescopic, Atlanta Astronomy Club

SOLAR SYSTEM OBSERVING PROGRAM

No. 220, **William Clarke,** Tucson Amateur Astronomy Association; No. 221, **Krista Lemoine,** Salt Lake Astronomical Society; No. 222, **Lisa Wentzel,** Twin City Amateur Astronomers; Nos. 223 & 223-B, **Brian McGuinness,** Northern Colorado Astronomical Society; No. 224-I, **Marie Lott,** Atlanta Astronomy Club

STELLAR EVOLUTION OBSERVING PROGRAM

No. 105, **Kevin Wilson,** Member-at-Large; No. 106, **Andrew Corkill,** Lifetime Member; No. 107, **Steve Riegel,** Colorado Springs Astronomical Society; No. 108, **Scott Donnell,** Colorado Springs Astronomical Society; No. 109, **Hans de Moor,** Member-at-Large; No. 110, **Bernard Venasse,** Member-at-Large

SUNSPOTTER OBSERVING PROGRAM

No. 232, **Tom Karnuta,** Member-at-Large; No. 233, **Steve Riegel,** Colorado Springs Astronomical Society; No. 234, **Dean Herring,** Raleigh Astronomy Club; No. 235, **Susan Herring,** Raleigh Astronomy Club; No. 236, **Brian Chopp,** Neville Public Museum Astronomical Society; No. 237, **Jonathan Cross,** Seattle Astronomical Society; No. 238, **William Castro,** Central Florida Astronomical Society; No. 239, **Edgar G. Fischer,** The Albuquerque Astronomical Society; No. 240-I, **Laurie V. Ansorge,** Lifetime Member; No. 241-I, **Steve Boerner,** Member-at-Large; No. 242, **Michael Martin,** Roanoke Valley Astronomical Society

TWO IN THE VIEW OBSERVING PROGRAM

No. 62, **Tony Edwards,** Island County Astronomical Society; No. 63, **Tim Moyer,** South Jersey Astronomy Club

UNIVERSE SAMPLER OBSERVING PROGRAM

Nos. 167-N & 167-T, **Dave Tosteson,** Minnesota Astronomical Society; No. 168-T, **Larry Bloom,** Longmont Astronomical Society

URBAN OBSERVING PROGRAM

No. 242, **Brian Hayward,** Rose City Astronomers

VARIABLE STAR OBSERVING PROGRAM

No. 59, **Mark Ellison,** Member-at-Large; No. 60, **Scott Cadwallader,** Baton Rouge Astronomical Society

MASTER OBSERVER PROGRESSION

OBSERVER AWARD

William Clarke, Tucson Amateur Astronomy Association; **Krista Lemonie,** Salt Lake Astronomical Society; **Lisa Wentzel,** Twin City Amateur Astronomers; **John Zimitsch,** Minnesota Astronomical Society

ADVANCED OBSERVER AWARD

Lisa Wentzel, Twin City Amateur Astronomers

MASTER IMAGER AWARD

Marie Lott, Atlanta Astronomy Club

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