Published by the Astronomical League
Vol. 72, No. 2 March 2020

Reflector

REMOTE OBSERVING IN PRACTICE

THE BOSS GREAT WALL

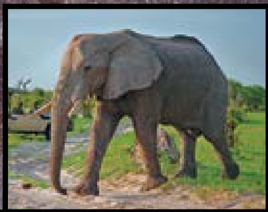
THE TRANSIT OF MERCURY AND THE ASTRONOMICAL UNIT

Take a Dream Trip

Join a Sky & Telescope Astronomy Tour

African Stargazing Safari

July 17–23, 2020



Join astronomer Stephen James O'Meara in wildlife-rich Botswana for evening stargazing and daytime safari drives at three luxury field camps. Only 16 spaces available! Optional extension to Victoria Falls.

skyandtelescope.com/botswana2020

S&T's 2020 solar eclipse cruise offers 2 minutes, 7 seconds of totality off the coast of Argentina and much more: Chilean fjords and glaciers, the legendary Drake Passage, and four days amid Antarctica's waters and icebergs.

skyandtelescope.com/chile2020

2020 Eclipse Cruise: Chile, Argentina, and Antarctica

Nov. 27–Dec. 19, 2020

Total Solar Eclipse in Patagonia

December 9–18, 2020

Come along with *Sky & Telescope* to view this celestial spectacle in the lakes region of southern Argentina. Experience breathtaking vistas of the lush landscape by day — and the southern sky's incomparable stars by night. Start and finish in cosmopolitan Buenos Aires.

skyandtelescope.com/argentina2020

Astronomy Across Italy

May 1–10, 2021

As you travel in comfort from Rome to Florence, Pisa, and Padua, visit some of the country's great astronomical sites: the Vatican Observatory, the Galileo Museum, Arcetri Observatory, and lots more. Enjoy fine food, hotels, and other classic Italian treats. Extensions in Rome and Venice available.

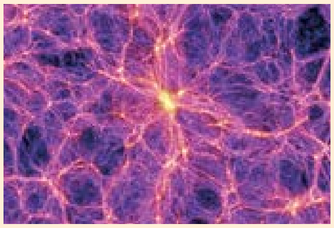
skyandtelescope.com/italy2021

See all *S&T* tours at skyandtelescope.com/astronomy-travel

Contents

PAGE 16

PAGE 18



PAGE 24

NOTE: Due to time and space constraints, we are unable to publish a Coming Events column in this issue. Please see ***astroleague.org*** for updates.

Cover image: *Matt Harbison (Barnard Astronomical Society of Chattanooga) captured this mosaic image of the Veil Nebula complex over four months (and with 120 hours of exposure) using a pair of William Optics FLT 132 APOs with QHY 16200A cameras.*

Reflector

The Astronomical League Magazine

Vol. 72, No. 2 • ISSN: 0034-2963 • March 2020

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

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

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

If you could have just *one* field resource, which should it be?

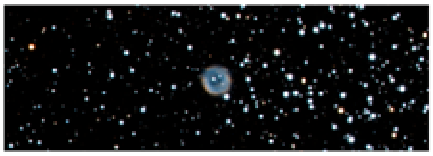
"Best 'at the scope' guide in existence. Made all the better with the addition of the great Moon section."
Peter Kurtz, Cape Cod Astronomical Society

"More useful to more people than the RASC Handbook"
Mark Kipperman, Naperville Astronomical Association

"Great field manual! THE best book to use with a GOTO scope!"
Joe Lalumia

"Four-for-four, Birren's work bats 1000."
Jim Barnett, review on CloudyNights

Newly updated to OITHv6.1. Available only from
www.BirrenDesign.com/astro.html
630-336-5321



Smart Planning for Imaging

People don't usually plan their imaging beyond finding objects that pass high in the sky. This is because they don't have enough information. Every camera and telescope combination is different. Every object in the sky is different. Basic questions arise that have no clear answers How long to expose to get a nice image? What sub exposure time to use? What order to observe the filters in? How much moonlight is allowed for a narrow band filter to still get a good result?

Large professional observatories have special purpose software that can answer these questions. Now, you too can have the answers using SkyTools 4 Imaging. Now there is a tool that can search every known object for the ones that are suitable for your imaging system, calculate the optimum filter order, and tell you the right sub exposure times to use. Not only that, but it can create mosaics graphically, organize your projects, track your progress, and create a searchable archive of your images.

What would you do with a tool like that?

SkyTools 4 Imaging
Skyhound.com

Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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

PAPER SUBSCRIPTIONS:

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

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

***REFLECTOR* AND CLUB ROSTER DEADLINES**

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

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

NATIONAL OFFICERS

President
Ron Kramer
9520 Dragonfly Avenue • Las Cruces, NM 88012
520-500-7295 • *president@astroleague.org*

Vice President
Carroll Iorg
9201 Ward Parkway, Suite 100 • Kansas City, MO 64114;
816-444-4878 • *vicepresident@astroleague.org*

Secretary
Chuck Allen
4005 St. Germaine Court., Louisville, KY 40207
502-693-5504 *chuckallen@gmail.com*

Treasurer
Bill Dillon
190 Settlers Road • Fincastle, VA 24090
703-674-8484 • *treasurer@astroleague.org*

Executive Secretary
Maynard Pittendreigh
3208 Little Oak Way • Orlando, FL 32812
770-237-2071 • *executivesecretary@astroleague.org*

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

National Observing Program Directors
Cliff Mygatt
cliffandchris@wavecable.com
Aaron B. Clevenson
aaron@clevenson.org
Al Lamperti
lamperti@temple.edu
Maynard Pittendreigh
maynard@pittendreigh.net

Astronomical League Historian
Mike Stewart 913-240-1238 • *AL_Historian@kc.rr.com*

LETTERS TO THE EDITOR
Send to *editor@astroleague.org* with subject line "letter to editor"

***REFLECTOR* STAFF**

Managing Editor
Ron Kramer
Mobile: 520-500-7295
managingeditor@astroleague.org

Editor
Kristine Larsen
larsen@ccsu.edu

Assistant Editor
Kevin Jones
j11.kevin@gmail.com

Photo Editor
Dan Crowson
photoeditor@astroleague.org

Design/Production
Michael Patterson
michael.patterson@stellafane.org

Advertising Representative
Carla Johns
970-567-8878
advertising@astroleague.org

Coming Events Editor
John Wagoner
astrowagon@verizon.net

To the Editor

This past September, my family and I visited France, primarily to go with my parents, as my dad, who is a World War II veteran, celebrated the 75th anniversary of the liberation of France, the Cathedral in Chartres, and the town of Lèves. Knowing ahead of time that we would have time after the anniversary in Paris to enjoy the usual sights, such as the Louvre Museum, the Eiffel Tower, and Arc de Triomphe, I also wanted to visit the popular and well-known Père Lachaise Cemetery.

Why that cemetery? Well, as long as I have been interested in astronomy, I have also been interested in the French astronomer from the 18th century, Charles Messier. As every astronomer knows, we have the Messier Catalog, a list of 110 deep-sky objects that he initially put together. What may not be known to some observers, however, is that Charles Messier was a comet hunter; there are at least 12 comet discoveries attributed to him. At the same time, he also saw many things that were not comets, such as open and globular star clusters, galaxies, and nebulae. While reading an astronomy magazine a few years ago, I saw that Messier was buried in the Père Lachaise Cemetery. When I learned we were going to spend a few days in Paris, visiting Messier's grave became one of the things on my bucket list of things to do.

If you do a search on this cemetery you will be directed to a list of who's buried there: famous people like Oscar Wilde, Marcel Marceau, Jim Morrison of the Doors, and many other artists, politicians, actors, and the like. Even though Charles Messier is not listed among the famous people buried there, there are ways to find the grave. My wife, brother, and two of my children went on a quest to find his grave site. His remains are in section 11, but the exact spot is not specified on any map. However, we did know that the grave was close to that of composer Frédéric Chopin.

My brother finally found Charles Messier's gravesite. Compared to others, such as Jim Morrison's, the Messier gravesite is rather unimpressive. The name is inscribed in the headstone, but it is slightly obscured and weatherworn; the monument is tucked behind other graves. Still, we found it and paid our respects to the French astronomer and comet-hunter. It was an honor to be there and visit his resting place.

Addendum: While were in Chartres, my father was awarded the Legion of Honor medal, established by Napoléon Bonaparte, for meritorious service during World War II. I say this because Charles Messier was also awarded this same medal, the Legion of Honor, by Bonaparte himself.

—Paul W. Schulz
President, Desert Skygazers Astronomy Club
Safford, Arizona

Call for Nominations

The two-year terms of the offices of president and vice president end on August 31, 2020. If you are interested in using your talents to serve in either one of these two important positions, we would like to hear from you. Please volunteer!

For specific information regarding the duties and responsibilities of the president and vice president, please refer to the League's bylaws, which can be accessed on the League website at *astroleague.org.*

Candidates should send to Nominating Committee co-chair John Goss, *goss.john@gmail.com,* a background statement explaining why they are interested along with a photo of themselves for publication in the *Reflector*. Please limit all statements to approximately 250 words. All nomination materials must be submitted by March 15, 2020, so they can be announced in the June *Reflector*.

Erratum

An image accompanying James Dire's article in the December 2019 issue was inadvertently cropped in a way that omitted a double star from the lower right-hand corner that had been mentioned in the article. We apologize for any confusion this error caused.

Sky Puppies Program

I found mentoring some children through the Sky Puppies Program quite rewarding for me, to say the least. I went to the local library and proposed the program, asking if I could use their classroom to teach kids about astronomy. They were all for it. I came up with a signup sheet to allow up to six kids to participate, and on the signup sheet I included all the expected requirements. I asked for each student's name, age, and a signature from their parent. This way the parent would also understand what was required, and they could participate if they wished. I set it up as an after-school activity for one hour on one day per week in the library classroom. I made name badges for all of us so we could remember everyone's names, plus this made the kids feel important. I had a notebook prepared for them with some information, and this also gave them a place to store their work as the class progressed.

After two weeks of classroom time I invited them over to my house for some observing for the first time. I had several telescopes set up and told them they could invite their parents and all their siblings if they wanted to. I wasn't expecting them to do much work–I just wanted them to experience being out under some stars, looking up. They invited all their family members who cared to come out, and it was a great experience. This was just an observing outreach party for them because I knew they would be too excited to focus on getting any work done. I wanted it to be fun for them.

We used my dry-erase board to draw their constellations using an assortment of colored markers. I tried other ideas, but the dry erase board was the kids' favorite. We learned how to use a planisphere and I helped them understand how the stars cross the sky from east to west. I pointed out that constellations near the western horizon they would soon set, not to be seen in the early evening for another six months or so. They learned about the six major circumpolar constellations and what that meant. We learned about some mythical stories from two books, *The Mythology of the Night Sky* by David E. Falkner and *Night Sky* by Jonathan Poppele. We also used my astronomy constellation flash cards. This was a fun activity. I would show them each card and whoever correctly named that constellation got the card; the person with the most cards at the end got a small prize. Later I would draw the star pattern of a few constellations on the dry-erase board to see if they could name them. I would highlight the alpha star, or some object in that constellation, and we would talk about those. We even discussed the life cycle of stars. I used PowerPoint presentations several times, and showed them a short video, "Cosmic Collisions," narrated by Robert Redford.

The parents were very supportive during the stargazing outings in my backyard. When the weather was going to bless us with a clear night, they would bring the kids over for some observing. I did learn it is much easier if you work with one or two of the kids instead of all five at the same time when observing and pointing out constellations. They were more productive and didn't have to wait their turn to point out constellations, especially important when it was cold outside. The parents enjoyed observing with us.

I used spreadsheets to track each child's progress; each of the kids had times when they were unable to attend because of other activities or personal choice. This way I could use this information to show them where they were in the program and what they needed to do to complete each project.

When it came time for the kids to present their robotic mission project, I was surprised how eager they were to present their topic. They all did such a wonderful job of it. A pair of sisters worked together on a project about the OSIRIS-Rex asteroid sample return mission, and I was really impressed with their presentation. They took turns explaining the mission, going back and forth four or five times, and did a great job. One nine-year-old did a fantastic presentation on the LCROSS mission; he did this all from memory without note cards. He pointed out some great details about the mission, and he was amazing. This particular student is home-schooled and his mother works at the library. I was blown away by all these kids. I can't believe how much fun this was.

I added other activities not on their required project list to help them understand how the stars rotate around above our heads. I showed them how to tell time using the Little Dipper using the star clock plans available at *skyandtelescope.com/astronomy-resources/make-a-star-clock*. I made them a small dial showing the Little Dipper with Polaris as the central point. The outer circle had the months of the year; you hold the current month at the top then rotate the inner dial to show the Little Dipper in the same position in the sky as you see it. A cutout window shows you the time. You add an hour if it is during daylight saving time; I also explained why that was important.

This Sky Puppies Program was as much a wonderful experience for me as it was for the kids. I can't get over how much I took away from this, just like the kids in my class did. Five kids completed this program and I look forward to another classroom of Sky Puppies.

—Jerelyn Ramirez

International Dark-Sky Association

THE SATELLITE MENACE

I have been around a long time and can remember the launch of Sputnik 1 in 1957. The first satellite I observed was the rocket body for Sputnik 3 in 1958. My first satellite image was of Echo 1 in 1962 (figure 1). I used to enjoy observing satellites in the pre-dawn sky while walking during my working days. Now, because I am retired, I enjoy them more when observing in the evening. I especially like the bright passes of the International Space Station.

Since I retired five years ago, I have really stepped up visual observing and astrophotography at my remote Grasslands Observatory southeast of Tucson near the small community of Sonoita, Arizona. Fort Huachuca, a major Army base, is situated on the edge of Sierra Vista, Arizona, about 20 miles from the observatory. For many years, an RQ-7 Shadow drone has flown out of the base, usually in the early evening. I don't know if it is for training or is looking for bad actors. It often flies over the observatory and has a distinctive pattern of strobe lights on its wings (figure 2). Previously it wasn't much of a bother,

Figure 1: *Echo I Satellite July 21, 1962 11:50 pm EST. Kodak Tri-X film 5-minute exposure with a Brownie Hawkeye Camera (45 mm f/2.8 lens). Echo I was a 100-foot diameter reflective Mylar balloon in an approximate 1500 km high orbit.*

but now it seems to show up on many of my astrophotographs every night and is often accompanied by trails from planes or satellites (figure 3). This has become bothersome, and causes me to discard many otherwise-useful images.

Because of my recent experience with drones, satellites, and planes showing up on my astrophotos, I became sensitized to the issue of satellites and associated space debris. Modern technology has made it possible to "inexpensively" launch dozens, even hundreds, and possibly thousands, of tiny satellites at one time.

On May 23, 2019, SpaceX launched a group of sixty satellites into low Earth orbit. They will certainly contribute to space debris, and they can be bright enough to be visible to the naked eye and leave innumerable trails on astronomical images. They are truly endangering the operation of professional observatories and becoming a threat to dark skies worldwide. Moreover, the

Figure 2: *RQ-7 Shadow drone making two passes during 300-second exposure of NGC 2359, Takahashi Epsilon 180 f/2.8 telescope, Canon 20Da camera, ISO 800. Note the dots showing the blinking of the drone's strobe lights.*

U.S. Federal Communications Commission has already approved the operation of more than 7,000 SpaceX satellites in low Earth orbit. Many other companies and nations will certainly follow the SpaceX example, which I believe may be the worst threat ever to dark skies, exceeding that of traditional light pollution.

If we are not vigilant, soon there may be no place on Earth with a truly dark sky, as hundreds of satellites visibly pass overhead in the early evening and predawn hours. If the satellites are low (500 km or lower), even if they are quite small (several cubic feet), they can be bright enough to be seen and will show up on astrophotos. At least they will have a limited, few-year lifespan before burning up in the atmosphere. Low Earth orbit objects should not be visible all night long, being in the Earth's shadow a good part of the night. If these satellites are at higher altitudes, then they will be somewhat fainter but visible later in the evening and will stay in orbit possibly for decades.

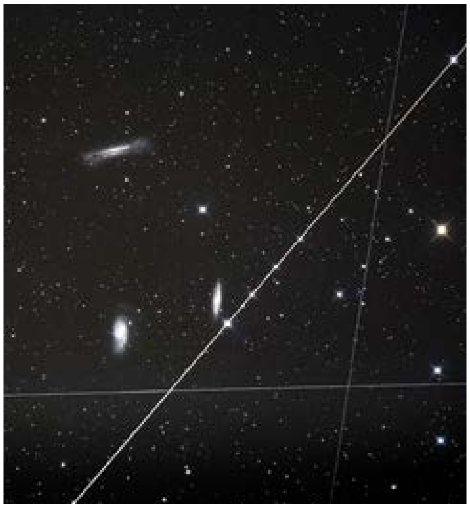


Figure 3: *NGC 3628 (top), M66 (left), and M65 (right), 450-second exposure with Takahashi Epsilon 180 f/2.8 telescope, Canon 60Da camera, ISO 1600. Note the diagonal pass of the RQ-7 Shadow drone with its strobe lights. There are at least two other trails from satellites or airplanes in this picture.*

This satellite menace has caught the attention of IDA and other protectors of the night sky. You can see IDA's initial press release concerning this problem at *darksky.org/starlink-response*. These SpaceX satellites will spread out and get fainter as they go to their final orbits. What concerns me the most is the example this sets. A supposedly "green" company had little forethought or concern about the night sky. I think IDA and other environmental organizations, as well as those concerned with space debris, should collect their thoughts and get organized. The proper United States authorities need to develop stringent guidelines for satellite deployment that include minimizing space debris and minimizing the ill effects of thousands of satellites passing overhead on the night sky.

The United States has to work with the international community to get the spacefaring nations to adhere to most stringent rules in these regards as a matter of international law. Otherwise, amateur and professional astronomy as we know it may be forever altered beyond easy repair. Ordinary light pollution is a vast problem, but at least the solutions, in theory, are simple – turn off unneeded lights, don't put in lights where they are not needed, use the proper amount of lighting, and direct the light down to the ground, not up into the sky. What do we do with thousands of visible satellites in orbits that last for years?

—Tim Hunter
Co-founder, IDA

Editor's note: *SpaceX is reportedly responding to astronomers' complaints about the Starlink satellite network and is testing lower-reflective coatings. Keep track of the American Astronomical Society's efforts to mitigate the impact to ground-based astronomy at* aas.org/posts/advocacy/2019/12/aas-works-mitigate-impact-satellite-constellations-ground-based-observing.

Full STEAM Ahead

CAN YOU BELIEVE IT?!

It's been two years in the making, and now, it's finally here – the first ALCon Jr. Family STEAM Conference! Of course, it would never have come to fruition if it wasn't for the support of the leadership of the Astronomical League starting with the late Bill Bogardus. The rest of the AL crew – including president Ron Kramer, vice president Carroll Iorg, and executive secretary Maynard Pittendreigh – have provided great guidance through this whole process. In addition, several partnerships have been forged with organizations and companies who share the vision for this conference and the lasting impact on the families involved.

First, a man for whom I am truly grateful and who shares my outreach goals is Rob Teeter from Teeter's Telescopes. As the amateur telescope making workshop developed, Pat Murnaghan of e-Scopes (Coulter Optics) has come on board, embracing the vision for this conference, and as of the writing of this article, Greg Bragg from Celestron is planning a special offer for those making a telescope at this event. Another key person in this whole project is Jim Greenhouse and his staff from the New Mexico Museum of Natural History and Science, which is where all the STEAM activities will be happening. Two other major supporters are Jody Vanesky from the Albuquerque Museum and Edwina Andrade from the Explora Science Center and Children's Museum.

ALCon Jr. has two aspects: an amateur telescope making Workshop for 6th-graders through adults, and Saturday STEAM activities, for elementary school students. For details, please refer to the schedule on the *astroleague .org* website. Activities are handicap accessible. The telescopes will be constructed in the multi-purpose room, which can hold about 30 tables of telescopes on a first-come, first-served basis. Volunteers would be welcome here, especially if you have a battery-operated hand drill! No telescope making experience is required.

Thursday, July 16, from 9 a.m. to 1 p.m. is part one of the ATM workshop, with the finishing and collimating of scopes on Friday, July 17, from 9 a.m. to 1 p.m. First light will occur on Friday night with the trip to a star party (listed on the main adult schedule found on the website). Those planning on making a telescope, please note the following finished dimensions: base – 19 inches high and 12-inch squared bottom; tube – 8 inches in diameter and 48 inches long. Please make proper travel arrangements and room for your new telescope! The original vision was to help subsidize the telescopes through calendar sales for those who needed financial assistance, since the goal is to make a scope, not to make a profit. As of the writing of this article, finances and donations are still being assembled and an update will be forthcoming on the final plan.

While the older students are making a telescope, the elementary students will be enjoying special rates at neighboring museums in the same complex. On Thursday, July 16, from 1 to 2:30 p.m., families will enjoy the Albuquerque Museum with a tour and family art activity, and then from 3 to 5 p.m. a hands-on experience at the Explora Science Center and Children's Museum. As the telescopes are being finished, family members will be treated to a special tour from the New Mexico Museum of Natural History and Science on Friday, July 17, from 9 a.m. to 1 p.m. Thanks to Jim Greenhouse, this museum tour is waiving admission fees to ALCon Jr. registrants.

The second part of this event is the Saturday astronomy STEAM activities for elementary school students grades K–5. The classrooms are located at the New Mexico Museum of Natural History and Science where the lower and upper elementary students will each have their own room with activities appropriate for their grade band. Other-abled family members and students are welcome to join in the fun. We are currently looking at a registration limit of 40 lower- and 40 upper-elementary students. Julie Yuan from the museum café has offered to make lunches available for purchase on site, but you are welcome to bring a lunch and snacks for your student instead.

New Mexico Museum of Natural History and Science

On Saturday, we will have a great time with sessions run by Dave Prosper and Vivian White from the Night Sky Network and 2018 Horkheimer/Smith Award winner Abby Bollenbach. Volunteers – outreach astronomers and teachers – are all welcome to join us as we conduct activities on planets, constellations, lunar and solar observing, and black holes. Some tactile resources will be in tow in case we get to welcome other-abled students. Also included is the night segment starting at 6:30 for those parents desiring to attend the ALCon 2020 banquet. The ALCon Jr. attendees will be all together for their nighttime festivities.

Check out the schedule and registration information, and if you have any questions or want to volunteer, please contact me at *astroleague_steam@cox.net.*

—Peggy Walker

Night Sky Network

FORGING OUTREACH PARTNERSHIPS

Astronomy is for everyone! Your club's astronomy events may already reach a lot of folks, but you may be able to find different audiences – and possibly in greater numbers – by creating partnerships with other organizations in your community. They may even be looking for astronomers themselves!

Libraries, parks, and museums often host events themed around space and astronomy. You may have already worked out a relationship with one of these establishments, often called an informal learning center (versus the formal learning centers found at schools or colleges). As the name implies, informal learning centers are places where people gather without any set objectives or requirements. People might go to the library to find a book, use the internet, or participate in an afternoon program, or maybe even just to see what's new. The same for a local museum; you may take a guided tour, but there's no test afterwards, and you can also just check out the exhibits on your own. Astronomy outreach is usually rather informal as well, as you may already know from many random discussions at the eyepiece!

Support Your Local Library

Libraries aren't just quiet places for checking out books. You probably already know this, but in case you haven't been to your local library in a while, definitely make a point to stop in and get that library card renewed! Libraries are community hubs, with regular activities and group meetings. Librarians are always looking for potential new activities for their patrons and to attract community attention and support, and astronomy is often the perfect activity to do outside their doors, day or night. If your club is also needed inside to do a talk about some fascinating space topic, the Night Sky Network has materials to help with that; some of the most popular can be downloaded at *bit.ly/nsnpresentations*. There is even the NASA@MyLibrary program, which helps local libraries connect their patrons with STEM learning and NASA science. Find out more about NASA@MyLibrary at *bit.ly/nasalibrary.*

Half the Park Is After Dark

Many parks of all sizes and levels of organization have nighttime activities. For national parks, their often-pristine locations make them ideal for meteor shower watches, or star parties where visitors get to view the splendor of the Milky Way. Even light-polluted urban parks are great places to host solar observing, eclipse viewing, and regular planet and stargazing events. Parks are often little darker-sky holdouts surrounded by light pollution. Even if you can't see the Milky Way from your local park you may still be impressed with the amount of stars you can see versus the viewing quality in the rest of town. Parks are natural centers for people to congregate, either casually or as a destination, and are great places to perform outreach. If you partner with larger parks, you may even befriend a park ranger that knows the sky better than you!

Museums Attract the Curious

Volunteers at science museums get a lot of the same questions you get at the telescope, which makes them a natural fit for astronomy clubs! STEM days are perfect chances to bring in your club's Night Sky Network toolkits for fun demos (find out more about NSN toolkits at *bit.ly/nsntoolkits*). If the museum doesn't celebrate Astronomy Day with any special events, your club could help them start, too. The NISE Network (short for National Informal STEM Education) is dedicated to helping museums with their science education efforts, and also offers museums toolkits filled with fun activities and resources, similar to Night Sky Network toolkits. You can find out more about NISE and check out some of their resources at *nisenet.org.*

Partnering with other groups brings additional benefits, aside from increased visibility for your club; there are practical concerns that partner organizations may be able to help with. For example, outreach volunteers may feel overwhelmed trying to keep up with requests; or, they may be underwhelmed with a lack of requests for events. Your club may not have a regular spot for monthly stargazing or business meetings. Partners can help at events, as their folks can help with location, organization, publicity, and other logistical items. Libraries and museums may be able to offer spaces for regular meetings and presentations; parks may have great spots for regular stargazing events. If you find your relationships growing closer with these partners, you may find that your club may need a designated liaison for those organizations – and they may send their own representatives to your meetings as well, which will help tremendously your groups' relationship and future event planning.

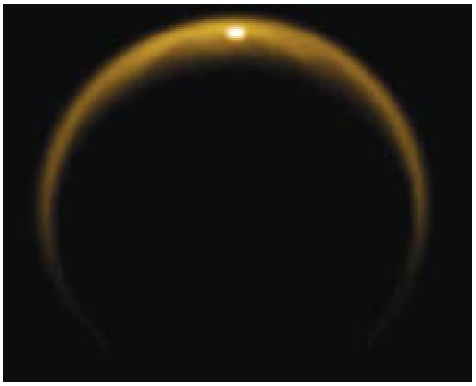
These are just several examples of potential partners for your club and some of the benefits of partnering up. Keep your search open to other groups and organizations that may wish to join up with your club, like local schools, churches, or scouts. Great partners could be anywhere!

—David Prosper

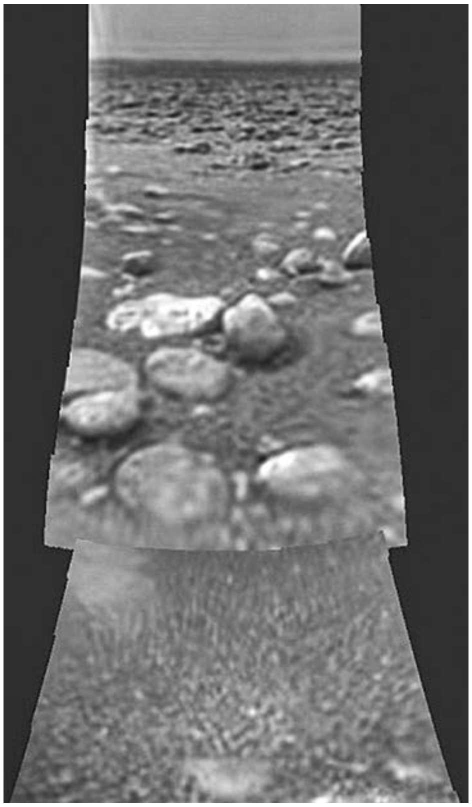
Wanderers in the Neighborhood

TITAN

Before the Olympian Greek gods could rule the universe (or at least the Earth), they had to defeat a pantheon of gods called the Titans. Just as the Titans had overthrown their parents, their offspring – the Olympians – overthrew them. The defeated Titans were sent to rule in the underworld. The leader of these older gods was Cronus, whose Roman name was Saturn, the name given



The bright spot at the top of this image is sunlight reflecting off the mirror-flat surface of a lake on Titan. This infrared image has been colorized to match the visible-light orange color of this moon. This glint was captured by the Cassini spacecraft's VIMS instrument at a wavelength of 5 microns on July 8, 2009. Credit: NASA / JPL-Caltech / University of Arizona / DLR



The ESA's Huygens probe piggybacked on the Cassini spacecraft until it was released to land on Titan. After landing, it took these images of the surface of Titan near Texel Facula in the Shangri-La region just south of Titan's equator. The smallest rounded rocks visible are about tenth of an inch, while the largest are almost eight inches across. Credit: ESA / NASA / JPL / University of Arizona

to the sixth planet in our Solar System. The moons of this planet were named based on a suggestion in 1847 by English astronomer John Herschel. He named the brightest moon after the pre-Olympian gods as a whole, Titan. The other six moons known at that time were named after individual Titans: Enceladus, Mimas, Tethys, Dione, Rhea, and Iapetus.

Besides being the largest moon in the Saturnian system, Titan is the second-largest moon in the Solar System after Jupiter's moon Ganymede. Larger than the planet Mercury, Titan is unique in that it is the only known moon to have a dense, although cold, atmosphere. At almost ten times the Earth's distance from the Sun, this moon gets only one percent of the solar energy that Earth receives.

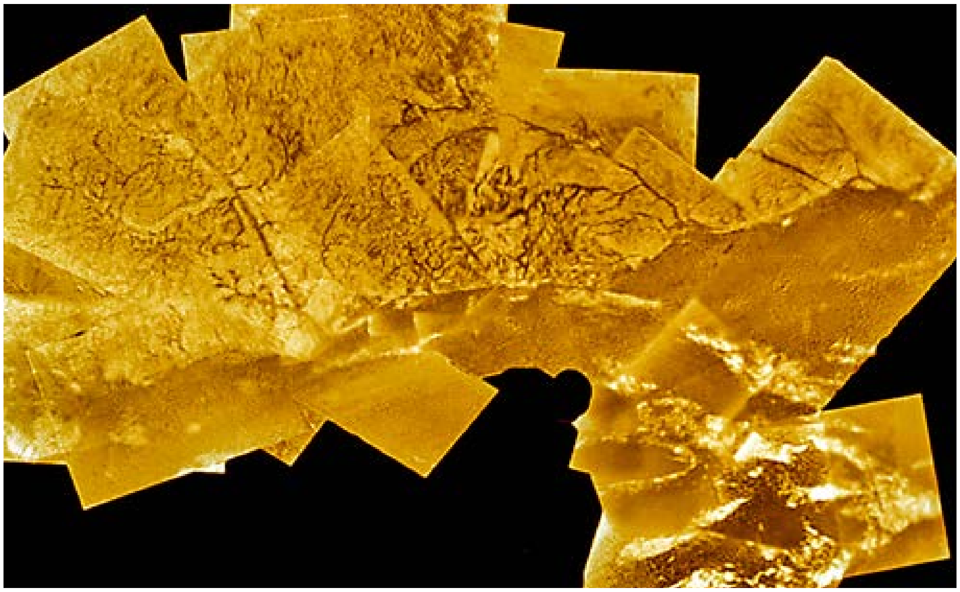
Titan's density is similar to that of the Jovian moons Ganymede and Callisto, suggesting that Titan is composed of about half water and half rock. A substantial fraction of the rock material has settled to the center of the moon, forming a rocky core that is mixed with water. Above the core is a layer of solid "ice VI," a water ice that forms tetragonal crystals of solid ice below the freezing point but at very high pressure. Above the ice VI is an ocean of liquid water, mixed with ammonia that acts like antifreeze, keeping the water liquid even at below-freezing temperatures.

The liquid ocean isolates the surface from the interior, allowing surface features to move relative to the core. The Cassini spacecraft observed features moving nineteen miles in a two-year period from 2005 to 2007. The surface is supported by a layer of normal ice floating on the subsurface ocean. The surface itself is geologically young, showing few craters, with those that remain filled in by hydrocarbon rain. The surface is mainly water ice mixed with hydrocarbons. There may also be methane and ammonia ice patches on the surface.

Cassini's radar data showed scattered lakes on Titan's surface, making it the only other body in the Solar System other than the Earth with stable liquid on its surface. The lakes are filled with liquid methane and ethane. One model has the lakes forming when liquid methane dissolves the bedrock ice that is mixed with solid organic compounds, leaving a depression that fills with liquid. Another model has pockets of liquid nitrogen trapped under Titan's surface warming to form gas that explosively decompresses, again leaving depressions that fill in. It is possible that some lakes formed by dissolution and others by the explosive process.

Much of what we know about the surface is thanks to the Huygens probe that landed on the surface of Titan on January 14, 2005. Huygens rode to Saturn on the Cassini probe and parachuted to the surface, collecting data on the atmosphere during the descent. It also imaged the surface during the descent, showing a large plateau with a familiarly Earth-like drainage system of small channels merging into larger rivers. The rivers, most likely of liquid ethane and methane, flowed into a broad, dark, lowland area. The Huygens landing site may have been a dry riverbed, with rounded cobbles four to six inches in diameter, probably composed of hydrocarbons and water ice, resting on a darker granular surface.

Titan's atmosphere is twice as thick as Earth's, making it hard to see the surface in visible light from space. Infrared light can penetrate the atmosphere, and Cassini acquired many infrared images of the surface. The surface it saw is between one hundred million and one billion years old, marked with light and dark features. One of the largest of these is Xanadu, a large, reflective equatorial area about the size of Australia, hosting rough terrain that is better at reflecting light in all directions than a smooth surface.



During the Huygens spacecraft's two-and-a-half-hour drop to Titan's surface, it captured many images. This mosaic from those images depicts the drainage system near the landing site. The rivers on Titan transport liquid hydrocarbons rather than water. The riverbeds are dry most of the time, but become active when methane storms drop large amounts of liquid onto the surface, just like thunderstorms on Earth. Courtesy ESA / NASA / JPL / University of Arizona

The bright area named Xanadu not only reflects light better, but radar signals as well. Cassini's radar confirmed that Xanadu's surface was rough, reflecting the radar signals better than the smooth darker regions. There are two types of dark regions, ones composed mostly of water ice, like Shangri-La, and ones covered with dunes, like Notus Undae. Dunes are generated by wind, and wind requires an atmosphere. Titan's dense atmosphere is ninety-seven percent nitrogen. It is the only nitrogen-rich atmosphere in the Solar System besides our own. Methane makes up most of the rest of the atmosphere with a little hydrogen and small amounts of other gases.

Titan's orbit around Saturn is tilted about twenty-seven degrees to the ecliptic, similar to that of Saturn itself. This gives each hemisphere more sunlight than the other for about fifteen years before Titan passes through the equinox and the other hemisphere then gets more sunlight. When a hemisphere receives more sunlight, its surface heats, causing the warm air to rise in that hemisphere and flow toward the other hemisphere at high altitude. When it reaches the cooler hemisphere, the air chills and then sinks back toward the ground. At the next equinox, the winds slow and reverse direction.

Computer simulations of Titan's atmosphere predict that around the equinox, methane storms form with downdrafts that flatten out into horizontal winds around twenty-five miles per hour, which can shape Titan's dunes. The simulation was confirmed when a series of methane storms appeared in Titan's equatorial desert regions in 2010, early spring in Titan's northern hemisphere.

The most distinctive feature of Titan from space is the orange color spread uniformly over its disk. While nitrogen is clear at visible wavelengths, this haze is likely the result of complex hydrocarbons in the atmosphere. Carbon dioxide, methane, and ethane combined with water and nitrogen are exposed to solar ultraviolet radiation and cosmic rays to form tholins, disordered polymer-like materials that comprise multiple layers in the atmosphere. Tholins have an orange hue and the large molecular chains block visible light, hiding t he surface of the planet from space.

The methane on Titan should have been broken down by solar ultraviolet radiation a billion years ago. The continued existence of methane indicates that there must be a source on Titan renewing the methane in the atmosphere. While impacts by comets could bring methane to the moon, they would also bring carbon monoxide, but there is a thousand times more methane than carbon monoxide, so comets are not the source. It is likely that Titan itself is refreshing the methane by cryovolcanic eruptions releasing material from the interior.

With the existence of hydrocarbons on Titan, there is the possibility of life existing there, most likely microscopic, in the lakes scattered across the surface. In 2019, NASA approved Dragonfly, a rotocraft-lander that will survey locations on

Titan for prebiotic chemical processes. NASA is also proposing an autonomous submarine to sail under the Great Lakes–sized lake Kraken Mare. What we will find in this lake will open a new vista in our understanding of this amazing moon.

—Berton Stevens

Deep-Sky Objects

HICKSON 68

High overhead during spring evenings lies the modest and indistinct constellation Canes Venatici. Devoid of bright stars, star clusters, and nebulae, the constellation more than makes up for this by being home to hundreds of galaxies, some bright and some not so bright. Several of Canes Venatici's galaxies are quite spectacular show-pieces. These include M51, M63, and M106. But in this article, I want to highlight a group of five galaxies, collectively called Hickson 68, that can all be captured in the same eyepiece field.

Hickson 68 is the 68th entry in Paul Hickson's catalogue of a hundred small compact galaxy groups. The five main galaxies comprising Hickson 68 are NGC 5350, 5353, 5354, 5355, and 5358. All but NGC 5358 were discovered in 1788 by William Herschel using his 18.7-inch reflector. Édouard Stephan (for whom Stephan's Quintet in Pegasus is named) discovered the faintest member, NGC 5358, in 1880.

Hickson 68 is not the easiest galaxy group to find as it does not lie near any bright stars. The group resides near the central-east edge of Canes Venatici, approximately nine degrees south of the star Alkaid (the end star of the Big Dipper's han-dle). The group also lies 13 degrees west of the bright star Nekkar in Boötes. With a polar-aligned equatorial mount, Hickson 68 can be found by centering Nekkar and slewing one hour and six minutes of right ascension to the west. On the west side of the galaxy group is a magnitude 6.5 orange star, HD121197, easily visible in a finder scope.

Three of the galaxies in Hickson 68 are bright enough to spy in 6- to 8-inch telescopes. The brightest is NGC 5353 shining at magnitude 11.0. NGC 5353 is a lenticular galaxy measuring 2.4 by 1.2 arcminutes. The galaxy's major axis runs northwest to southeast. Just north of it is NGC 5354, also a lenticular galaxy, shining at mag-nitude 11.4. It measures 3.0 by 1.1 arcminutes, with the major axis running north–south. Finally, four arcminutes north of NGC 5354 is the face-on barred spiral galaxy NGC 5350. It shines at mag-nitude 11.5 and is approximately the same size as NGC 5353. The spiral arms may be difficult to see with an 8-inch telescope, but bigger light buckets should reveal the spiral nature of this galaxy.

A 12-inch telescope should reveal the fourth member of Hickson 68, NGC 5355, four arcmin-utes northeast of NGC 5354. NGC 5355 is the third lenticular galaxy in the group. It shines at magnitude 13.2 and spans a mere 1.1 by 0.7 arcminutes. Finally, those with 14-inch and larger telescopes should be able to see a fifth galaxy in the eyepiece, the magnitude 14.6 edge-on spiral galaxy NGC 5258. It is a tiny 1.1 by 0.4 arcminutes and is 6 arcminutes east of NGC 5353. All five of these galaxies are 100 million light-years away.

The accompanying image of Hickson 68 was taken with a 102 mm f/7.9 refractor with a ST-2000XCM CCD camera. The exposure was 90 minutes. The bright star near the center of the image is HD121197. The five galaxies are to its left. On the very left edge of the image is NGC 5371, a face-on barred spiral galaxy shining at magnitude 10.6. NGC 5371 is at the same distance as Hickson 68 and may be a distant member of the group. The group may contain more than 20 galaxies, several of which appear as faint smudges on this image.

Spring is the best time of year to hunt distant galaxies at the eyepiece. Capturing multiple galaxies, like Hickson 68, in the same field of view is always exciting.

— Dr. James R. Dire
Kauai Educational Association for Science and Astronomy

All Things Astronomical

HUBBLE SPACE TELESCOPE HIGHLIGHTS THE CALDWELL CATALOG

In December 2019, NASA published the Hubble Space Telescope's version of the Caldwell cata-log. The online gallery features Hubble images of 56 of the 109 deep-sky objects identified by Brit-ish amateur astronomer and astronomy commu-nicator Sir Patrick (Caldwell) Moore as interesting targets for amateur astronomers that were not included in the more famous Messier catalog. The Caldwell catalog was published by *Sky & Telescope* in December 1995. While many of the Hubble pictures will already be familiar to astronomy enthusiasts (including popular images of the Cat's Eye Nebula, Antennae Galaxies, Carina Nebula, and Centaurus A), the catalog also includes 12 images not previously released by NASA that were newly processed for this project.

This new Hubble Caldwell collection includes an introduction providing background information about Sir Patrick Moore, his catalog, and Hubble's observations. Each Hubble image is accompanied by a caption that describes the object, explains the Hubble image, and provides basic information about when and where to look for that object in the night sky. The catalog is available on the NASA website at *nasa.gov/content/goddard/hubble-s-caldwell-catalog*. Hubble's images of the Caldwell objects are also found in a Flickr album at *flickr.com/photos/nasahubble/albums/72157711794133741*.

This Hubble image shows two galaxies locked in a fateful embrace. Caldwell 60 and Caldwell 61 are known as the Ringtail or Antennae galaxies. This violent clash has ripped stars from their host galaxies to form a streaming arc between the two combatants. Credit ESO/Hubble and NASA

FROM AROUND THE LEAGUE

HOW TO ATTRACT NEW MEMBERS

As a 65-year-old astronomer, as I reflect on my experiences, one of the biggest changes I've seen is the tremendous growth in the public's interest in astronomy. As a child and as a teenager, I was the lone astronomer in my schools. This was not unique to one community, as we moved frequently due to my dad's work requirements. Wherever I found myself, I was the only astronomer around.

Today there is an enormous interest in astronomy, thanks to space exploration, the Hubble Space Telescope, and the Internet keeping stellar wonders before us. As the national coordinator for the Astronomical League's Outreach Award, I can attest that local outreach events are attracting more people who want to look through our telescopes. For the first 100 submissions for the Outreach Award, the average attendance for a public viewing event was 89. Fifteen years later, the most recent 100 submissions have an average attendance for a public event of 169. If you put together all of the 27,358 outreach events during the life of the Outreach Award Program, we've reached over 3.9 million people!

This is great, but there is something missing in our outreach. Many of our clubs are not turning our visitors and guests into members. It is time to move to this next step. Let me offer a few suggestions for your club.

1. GET THE NAMES AND CONTACT INFORMATION OF YOUR GUESTS.

Offer a raffle, a free subscription to *Sky & Telescope* or *Astronomy* magazines, a free book, a planisphere, or some other prize. Have a drawing where it is not necessary to be present to win – that way people will provide their mailing addresses. You can use that information to invite people to club meetings and special events.

2. INVITE YOUR OUTREACH ATTENDEES TO BE GUESTS AT THE NEXT CLUB MEETING.

Even without the raffle, everyone can go home with flyers reminding them of your club's next meeting. Make sure you include the date, time, and place!

3. TRAIN SOME GREETERS.

Have you ever been the new person at a meeting and felt totally out of place with no one to talk with? Don't let your guests be that person! Train and prepare a few folks to be greeters who can introduce themselves to new visitors. One might not want to approach a stranger by asking, "Is this your first meeting," as the answer might be, "I am here every other month." Instead, have your greeters approach people with an honest and accurate, "I don't believe we've met. My name is Jane or Joe." Follow that up with simple conversation. Asking what sort of telescope they have and about their interests in astronomy are good ways to continue the conversation.

4. HAVE AN INTERESTING PROGRAM.

No one intentionally invites someone to a dull party or event. Don't invite someone to a dull club meeting. Be sure that every meeting offers a good program that is engaging for all levels of astronomers. One way to do this is to have all of the business conducted at the end of the meeting, and only if necessary. Elections may need to be handled at a meeting, but does a club really need to hear a 15-minute treasurer's report every month? That can be done among only the officers or in an email to the members. Keep your meetings focused on the skies!

5. HAVE ONE OR TWO SPECIAL EVENTS ANNUALLY AND INVITE ALL OF THE PAST YEAR'S GUESTS TO COME.

Some clubs organize one or two big meetings that are designed to bring in prospective members. You can invite all of those who attended the past year's outreach events to attend. Have a dynamic speaker with some appeal to the public. You might be able to secure an astronaut or a professional astronomer, or you might find that the skies themselves provide a special event in the form of an eclipse or transit.

6. HAVE A HEART FOR THE YOUTH.

Many of the people who attend public outreach events are children and youth. Most of my outreach has been with younger people because I work with schools and scouting organizations. We turn off many young people with our adult-focused astronomy meetings. Some of our clubs have already addressed this and are doing rather well. Some clubs offer a separate meeting just for the young. Others dedicate a segment of the meeting to youth. Either way, let me offer two things to keep in mind. First, we have an Observing Program specifically designed for children through age ten called "Sky Puppies."

Each meeting might take one or two of the activities from this program and focus on how to complete that part of the program. Second, take a lesson from scouting and other youth programs. While adults are the supervising leaders, many segments of these meetings are led by scouts. This gives young people leadership experience and helps them to learn together, in their own language and on their own terms. Youth leadership builds an ownership of the youth element of your club.

Years ago, the president of a civic organization told those of us who were members that securing new members required a figurative shotgun and rifle. For astronomy clubs, the shotgun approach is the public outreach program, while the rifle approach is targeted to specific people. I can see by the submissions for the Outreach Award that our clubs and individuals are doing a great job at public outreach events. Many of our clubs need to step it up with an intentional, well-planned program for securing new members in our clubs.

—Dr. W. Maynard Pittendreigh

FORT BEND ASTRONOMY CLUB RAKES IN THE AWARDS

One of our clubs is breaking records by earning its 200th Outreach Award. The award, given at Basic, Stellar, and Master levels, is one of the Astronomical League's most popular observing awards, and while many clubs are very active, the Fort Bend Astronomy Club in Texas has outpaced all other clubs. FBAC's president, Tony Wiese, is seen here presenting club member Abhi Gudipati with the club's 200th award. This club's 95 outreach volunteers (who have each achieved one or more of the 200 awards) have experienced such a fulfilling jour-

Photo credit: Steve Goldberg (FBAC)

ney since FBAC member and past president, Leonard Ferguson, received AL Outreach Award no. 10 in 2006. The March 2018 "Ripples Through Space and Time" *Reflector* article says it best: "Outreach is in our DNA. ... [It] is incredibly satisfying, often beyond measure. The camaraderie, the friendship, the vitality, the thanks, the faces of full wonder – these are why outreach continues to grow within our club."

THE STELLAFANE CONVENTION'S HARTNESS HOUSE WORKSHOP

The Stellafane Convention, a weekend gathering of amateur telescope makers and astronomy enthusiasts sponsored by the Springfield Telescope Makers (STM), has been held at the summit of Breezy Hill, near Springfield, Vermont, almost every year since 1926. The event's basic goal has remained the same since the 1920s: teaching people about telescope making and astronomy.

To facilitate this mission, a new sister event, the "Hartness House Workshop" held at the historic Hartness House Inn in Springfield on the Thursday of the Stellafane Convention, was created in 2009 at the suggestion of senior STM member Bert Willard. The subject of the workshop varies from year to year and has included the history of astronomy, antique telescopes and related instruments and their conservation, planetary astronomy, meteoritics, multiple-star astronomy, sub-arcsecond-resolution imaging, the search for exoplanets, and advanced telescope making.

The Hartness House Workshop features a series of relatively advanced talks related to the theme of the workshop, an open house at the Hartness–Porter Museum of Amateur Telescope Making, and observing with the Hartness turret telescope observatory, weather permitting. The 10-inch Hartness refractor, with optics by John A. Brashear, dates from 1910 and was mounted in one of the most innovative observatory designs in the world, which inspired the later Porter turret telescope observatory at Stellafane. The workshop's well-packed schedule makes for a full and very interesting day. Attendees overwhelmingly appreciate the intimate nature of the event, especially the scheduled breaks that allow everyone to talk shop.

Part of the crowd at last year's Hartness House Workshop, on advanced telescope making techniques. Photo: Tom Spirock

The subject for the 2020 Hartness House Workshop is "Professional–Amateur Collaboration and Small Observatory Science."

The slate of speakers includes Timothy Brothers (MIT), Robert Buchheim (Society for Astronomical Science), Dennis Conti (AAVSO), David Latham (CfA/Harvard), Emily Mailhot (Large Binocular Telescope), Caroline Odden (Phillips Academy, Andover), Joey Rodriguez (CfA/Harvard), and Chris Houghton and Paul Fucile (STM).

The success of the workshop since 2009 has depended entirely on the generosity of the distinguished speakers, the vast majority of whom participated without compensation or even travel support. The speakers have appreciated that all proceeds from the Hartness House Workshop, modest as they are, are dedicated to maintaining the Hartness–Porter Museum of Amateur Telescope Making in the underground rooms contiguous with the Hartness Observatory. The museum is open for tours during the workshop and the Stellafane Convention.

More information will be available soon at *stellafane.org.*

—Thomas Spirock, Daniel Lorraine, and John W. Briggs
Springfield Telescope Makers
Springfield, Vermont

SCOTT CONNER RECEIVES BALDAUF AWARD

At Hidden Hollow Star Party on September 28, 2019, Steven Scott Conner of the Evansville Astronomical Society (EAS) was awarded the Hans Baldauf Award, the Great Lakes Region's highest award for achievement in astronomy and public education. He received the award to a standing ovation at the EAS's Wahnsiedler Observatory on October 18.

Scott served as president of the EAS for 17 years, from 1999 to 2016, is currently club vice president, and has served as a club officer for 30 consecutive years. One of the most likeable people you will find in a nation of amateur astronomers, Scott holds the League's Master Outreach Award with over 760 hours of public education efforts over his lifetime, nearly five times the hours required for the award. A multiple national and regional award-winning astrophotographer, he is also a co-founder of the now 27-year-old Stars-at-the-Beach public observation at Newton-Stewart State Recreation Area on Patoka Lake in southern Indiana, an event that draws hundreds of people annually. He does extensive observing with an 18-inch Obsession and photography using his 10-inch Schmidt–Cassegrain and the observatory's 14-inch Schmidt–Cassegrain.

Scott Conner receiving the Hans Baldauf Award from Astronomical League secretary and past president Chuck Allen, left, and EAS president Anthony Bryan.

The award is named after Hans Baldauf (1892–1965), a benefactor and past president of the (now) Kalamazoo Astronomical Society, a prolific public educator in astronomy, and a leader in the development of Kalamazoo's planetarium.

More From Around the League →

KANSAS CLUB DONATES LIBRARY TELESCOPE

The Kansas Astronomical Observers donated their Horkheimer-funded telescope to the Silver Lake Public Library in Silver Lake, Kansas – a small rural town about 15 minutes northwest of Topeka – on December 10, 2019. The library is excited about this program, and already has several patrons ready to check out the telescope once it's available in their system. Our club has done a few educational astronomy events with this library with much response. I chose this library because of the rural community, and it is near where I live in Saint Marys, Kansas, about 15 minutes west of Silver Lake.

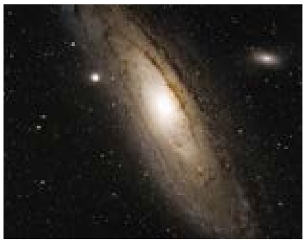
I sat down with Tracey DeShazo, the youth services librarian, and gave her an orientation to the telescope. I showed her how to read the star maps and other information to help the patrons star hop and locate objects, and how to distinguish a planet from a star. I plan to help the patrons if they have questions about the telescope, and give a training session to the first few patrons once the library is ready for them to check the telescope out. I also donated some laminated star maps and fundamental information sheets in a spiral-bound booklet for the patrons to use with the telescope, material that I downloaded from the Astronomical League's website. I hope to soon donate another telescope to a rural library.

—Jerelyn Ramirez
President, Kansas Astronomical Observers

Tracey DeShazo (left) and Jerelyn Ramirez. Photo credit: Paul Ramirez

REACHING FOR THE STARS HAS NEVER BEEN MORE FUN!

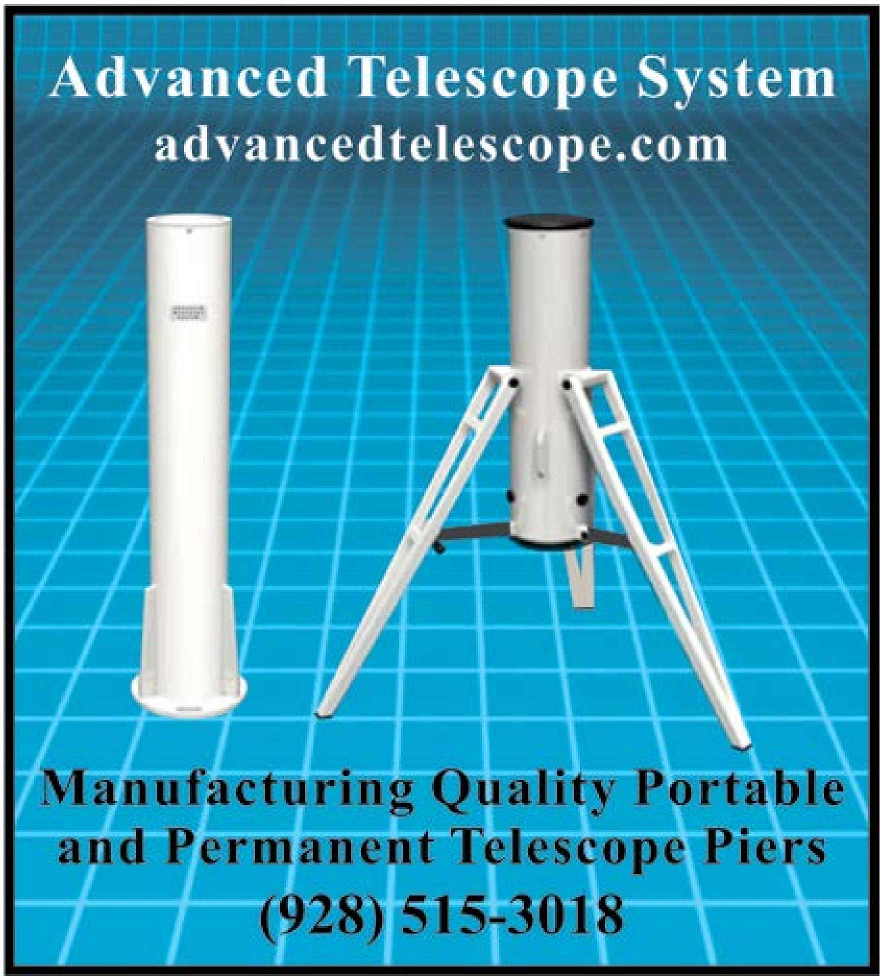
MONTANA LEARNING CENTER
CANYON FERRY LAKE



The Montana Learning Center offers an exceptional opportunity each summer for high school students interested in astronomy. Through the Explore the Universe five-day overnight camp, students experience the largest public use observatory in Montana with access to state-of-the-art telescopes and instrumentation to become astronomers. Cost is $750.

For more information and registration, visit:
http://montanalearning.org/camp-explore-the-universe/

406.475.3638
MONTANALEARNING.ORG


Advanced Telescope System
advancedtelescope.com
Manufacturing Quality Portable
and Permanent Telescope Piers
(928) 515-3018


MILE HIGH
ASTRONOMY
www.MileHighAstro.com
Astronomer Owned ✦ Expert Guidance
NOW OFFERING
TeleVue
Visionary
WILLIAM OPTICS
SB
SOFTWARE BISQUE
1-877-279-5280
Visit our
Denver, Colorado Showroom!


The Astronomer's Journal
100 Pages, 16 fields of entry, room for notes, two sketching circles, spiral bound.
Also available:
Messier and
H400 Journals
WWW.ASTROMAX.COM
American Association of
Amateur Astronomers
P.O. Box 7981
Dallas, TX 75209-0981


SIRIUS
OBSERVATORIES
We Challenge You
to Find a Better
Observatory!
Factory Finished & Assembled
Dismantle & Reassemble
Fiberglass Construction
Gelcoat Finishes
Weather Defiant
www.BeckstromObservatory.com


Staunton River Star Party - Spring 2020
IDA Dark Park
March 23 - 29, 2020
Fall - October 12 – 18, 2020
Staunton River State Park
Scottsburg, VA (near South Boston)
For more information or to register: www.stauntonriver-starparty.org
Full Party: $80 weekend: $45 Sponsored by: CHAOS


Rocky Mountain Star Stare
June 17-21 2020
RMSS.ORG
Keynotes by Apollo 17 LM Pilot
Harrison Schmitt &
Author Leonard David
"Return to the Moon" with us in
the clear dark mountain skies!

GALLERY

MEMBER ASTROPHOTOGRAPHS

All photos © 2020 by their respective creators.

ABOVE: Val Ricks (Houston Astronomical Society) captured this close-up view of Sharpless 132 from The Woodlands, Texas, using a TS ONTC 8-inch Newtonian (f/5) with a Starlight Xpress SXVF-H9 camera riding on top of a Takahashi NJP Temma 2 mount.

BELOW: Frank Colosimo (Delaware Valley Amateur Astronomers) captured this image of IC 5146 from his Blue Mountain Vista Observatory using a Hyperion 12.5-inch (f/9, 2532 mm) and a Celestron EdgeHD-11 (2760 mm) with a SBIG STL-11000 camera.

ABOVE: Andrew Klinger (North Texas Astronomical Society) captured this wide-field image of NGC 6888 from a dark site in Texas using a William Optics GT81 (reduced to f/4.7, 382 mm) with a ZWO ASI1600MM-Cool CMOS camera.

BELOW: Steven Bellavia (Amateur Observers' Society of New York) took this image of M31 using a 51 mm William Optics RedCat (f/4.9) Petzval refractor with a ZWO ASI183MM Pro CMOS camera on a SkyWatcher EQ6-R Pro mount.

Going Remote

BY ROBERT KIMBALL

An Astrophotographer's Experience in the Sacramento Mountains

I climbed up into Bill Stein's black Suburban and seconds later we were speeding east through the San Augustin Pass. We passed White Sands National Monument and Alamogordo and drove up the narrow mountain canyon to Cloudcroft. Fifteen minutes later we were at the gate to Bill's astronomy community, a total trip of exactly 100 miles. Bill engaged the four-wheel drive, pressed the gate opener, and we climbed steeply onto a rough dirt road to a small yellow cabin, the street sign indicating we are on Galaxy Way. Perched twenty feet below the cabin is a gigantic shed. It is here that my telescope will huddle through the winter under cold, dark, clear skies.

We are in Mayhill, New Mexico, and there is astronomy going on everywhere. On the south side of the valley is New Mexico Skies, a large enclave with a long white row of domes and several large sheds filled to the brim with gleaming telescopes. These are outrageously expensive setups, but there's not a soul in sight. Lynn Rice, the proprietor, greets us warmly and gives us a deluxe tour of every building. She thanks us profusely for calling before we arrived (clearly this is very important to her).

In one of the domes is a huge mount carrying perhaps 12 Takahashi FSQ 106 refractors each with its shiny new SBIG camera. This, I'm told, is the Qatar National Observatory. The large sheds are packed with setups, all absolutely unique, awaiting silent commands to come alive as the sun sets.

In the adjoining house we find a communal area that is both a library and a small dining area. This cozy lair once hummed with astrophotographers. Now it languishes in disrepair. Sadly, this astronomy community exists only in the virtual world of the Internet.

Dr. Bill Stein (AAVSO's first vice president) getting ready to open the roof

On the north side of the Mayhill valley are a series of astronomy communities with homeowners' associations and strict covenants such as no white lights after sunset, and shades down after sunset! Bill's property is in Star's End Estates, a dark refuge consisting of roughly twenty irregular lots. I am sure my William Optics 110 refractor is the smallest telescope to be found here. Directly behind Bill's cabin a huge new dome is springing up. Its 30-inch aperture telescope will undoubtably be the largest on the block.

During the day I race up and down a path to the observatory carrying parts of my setup through knee-deep weeds. Bill sits at his computer opening and closing the roof, which is groaning and grinding along its track. We adjust the limit switch and discuss how we might shim the track to make the roof's journey smoother.

Down the center of the observatory, north to south, are three evenly spaced piers. These are all occupied. I carefully select a small open space just east of the other scopes. I try to visualize all these telescopes moving and eventually become convinced that mine will never collide with the others.

New Mexico Skies, Mayhill, New Mexico – telescope hosting

Bill Stein's Observatory in Star's End Estates astronomy community, Mayhill, New Mexico

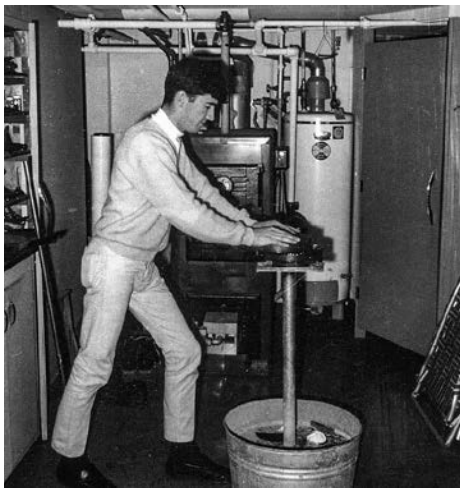
The whole afternoon I've heard nothing but our voices, but now that the sun is setting, new sounds whisper in the distance. I hear vents opening and then the soft whir of fans as the observatories push out the heat of the day. Finally, the creaks of domes turning, shutters opening, and the unique sound of mounts slewing call out in the twilight. Somewhere, distant fingers tap at keyboards and our community comes alive.

Looking northward into the observatory, my little William Optics 110 is nestled into the corner.

I digress for just a paragraph. Walking down Ipperwash Beach when I was about eleven years old, I saw a group of people gathered around a modest Newtonian telescope. I managed to get my first glance at the Moon after a little pushing and shoving. The hook was set deep. A year later, I was looking at Saturn through my own home-built three-inch telescope with a mirror purchased from my tattered Edmund Scientific catalog. I ground several mirrors, trekked to Shawinigan Falls, Quebec, for my first solar eclipse, and entered the University of Michigan as an astronomy major. Fast-forward to 2011, my wife and I are in Las Cruces, and after an astronomy hiatus of 30 years, I'm looking up again!

Of course, everything has changed. No more film processing, no more sighting along the tube, no more star hopping to Messier objects. Now Astromart is my best friend. I buy a nice Losmandy G11 equatorial mount once owned by Astronomical Society of Las Cruces (ALSC) member Kirby Benson, then a decent William Optics FLT 110 refractor. I attach my Sony DSLR and I am ready for serious astrophotography. Wrong! I learned quickly that getting exceptional astrophotographs is an iterative process – iterative intellectually and iterative financially.

Four years and perhaps $10,000 later (my wife questions this figure), most of the hurdles have fallen away. I set up my equipment, plug in five power cords and four USB cables, boot up the computer, and it runs almost all the time. The key phrase here is "almost all the time." Strange things occur with seemingly random vindictiveness, and I respond with religious zeal. Soon I have a rich doctrine of what needs to be plugged in first, which cables go in which ports, and still it never reaches the perfection of my dreams. Before going remote there is much more to be done. I can't drive two hundred miles round trip just to restart my computer or plug in a cable!



The author grinding a 10-inch primary mirror 60 years ago

Two large domes perched directly behind Bill's observatory at Star's End Estates

First, I decide to tackle the hardware problems. To focus, I can't stumble around to the front of the scope to put on a Bahtinov mask when I'm "remote," so I buy a precision Finger Lakes Instrumentation PDF auto focuser. What a joy it is to watch it systematically hone in on perfect focus. I learn for the first time how dramatically the focal point changes as temperatures rise and fall. Now my stars are sharp, but always slightly elongated. After many email exchanges with El Paso astrophotographer Erik Chesak, I finally accept what he told me in his first email – I've got flexure between my guide scope and my imaging scope.

I buy an Astrodon Monster MOAG off-axis guider and Erik mills a special holder for my guide camera. Finally, round stars! ASLC member John Kutney suggests I buy a powered USB hub to address my persistent USB problems. I follow his advice and add new high-grade USB cables and even little magnetic "chokes." Now things are talking to each other politely. As a finishing touch, I buy a compact Intel NUC (Next Unit of Comput-

The Vulture Head Nebula in Taurus (LBN 777). This is the integration of forty 900-second subs taken with an Atik 383L OSC camera.

er) computer. No monitor, no keyboard, no mouse, and most importantly, no battery. Now I have the telescope hardware to go remote.

Next, I clean up the software side of things. Initially, if I wanted to image M57, the Ring Nebula, I'd arrow up and down on my hand controller until I'd found M57 and then stand back as the mount made some awkward motions and headed towards Lyra. If I did my polar alignment carefully, the Ring would be in the camera's field of view, not centered, but at least I'd be close. Unfortunately, that's not good enough – I need to be spot-on. That's where "plate solving" comes to the rescue. If I had been told thirty years ago that ultimately my telescope would "read" the stars and position itself, I would have said you were crazy. But that's the miracle of plate solving. My camera takes a picture of the stars, and the plate solving software searches through a catalog of stars, makes some elaborate calculations, and then commands the mount to make the necessary adjustments. I select Sequence Generator Pro for my capture program because plate solving is built in. For guiding I use the tried and true PHD2, although for a while I used ASLC member Steve Barkes's "GuideDog" guiding software. I have PEMPro for recording and correcting my periodic worm errors and Astro-Physics Command Center (APCC) to replace my hand paddle. Next, Bill Stein introduces me to a real game changer, TeamViewer.

TeamViewer allows me to access Windows 10 on my NUC from Las Cruces using my Apple MacBook Pro. It is a miracle! Two or three clicks and I'm sitting in Mayhill. TeamViewer is free software for non-commercial users.

I've written computer software programs over the years, but I never really needed to learn about the technical workings of the Internet. This is a new challenge. Bill has his computers, mounts, and cameras running 24/7. I'd like to be able to turn mine off and on. I'm also afraid that somehow my telescope will lose its spatial orientation, so I buy a Foscam to monitor the "parked" position. I fire up YouTube for instruction and watch the "AwkwardHamster" carefully explain how to log in to my modem, set up port forwarding, and purchase a DDNS (Dynamic Domain Name System) address. I make it work on my home router, but I am not confident enough to breach the firewall on Bill's router.

I connect the Foscam to Bill's LAN (local area network) and view it with TeamViewer. To turn everything on and off, I buy an IP switch. Again, I confront new complications and router settings. Then on a dropdown menu, I see something about Google Hangouts. I learn that I can assign a Gmail address to my IP switch and then I can send it text commands. "Set on 1" turns plug one of my IP power switch on, and "Set off 1" turns it back off. It's so simple! I plug my NUC into plug one and my DC power supply into plug two and I'm ready to rock and roll.

"To open or not to open, that is the question." I've been set up at Bill's observatory for two moon cycles and the weather has not cooperated. Gone are the days when I could look up to check the weather. The astrophotographer directly behind Bill has a great website with sky monitoring equipment. I consult the Clear Sky Chart for Mayhill, then access our neighbor's all-sky camera and the seeing monitor. When these all look good, I shoot a text to Bill to see if we're opening. Bill is collecting variable star data and seems less concerned about the seeing than I am. I want the seeing and transparency to be perfect.

Bill often takes sky flats at dusk or dawn to calibrate his data. Consequently, he opens and closes the observatory most of the time and I just shoot anytime I want. Tonight, Bill is in Costa Rica so I use TeamViewer to access his computer and click the "open" button. On my Foscam, I watch the roof slowly open, I initiate my imaging sequence, and then head to bed. At 4 a.m. my phone vibrates. I wake up, stagger dull-eyed to my computer, and click the "close" button. When I take responsibility for opening and closing the observatory, I toss and turn most of the night. Waking up and finding three inches of snow on our equipment is a recurring nightmare.

The nights are lengthening now as we approach the winter solstice. I discover that unlike my backyard, I can image several targets on the same night. I start with a target in the east and follow it across the meridian to the west; then I head east again to pick up a new target and repeat the process. On a clear night, I can image for around ten hours. I've had to spend a lot more time picking targets than I expected. Besides my selected targets, I've been imaging Comet 46D/Wirtanen as it approaches perihelion. Seeing it brighten night after night is thrilling.Going remote has been challenging. Getting my equipment to perform reliably entailed buying just the right gear. Getting everything to hang on the Internet was more challenging, but it has all worked flawlessly and the images are the best I've ever taken. It's not for everyone, but I consider "going remote" a stunning experience. ★

Citizen ToM and the Astronomical Unit

BY ZACK STOCKBRIDGE

Mercury cast its shadow on the Earth several months ago. The small, dark silhouette of the planet snuck between us and the Sun for a few hours, blocking such a small piece of the solar disk that it was impossible to see the small planet without magnification (and, of course, a proper solar filter).

The Moon did the same thing back in July, but unlike solar eclipses, a planet transiting the Sun is visible to everyone on the daytime side of the Earth. Mercury's transit was also far less dramatic than a solar eclipse. As a matter of fact, sunspots commonly appear larger than Mercury's disk.

Much of America missed the transit entirely due to a large weather system that swept across the country, clouds obscuring the last planetary transit to be seen on U.S. soil for another 30 years. For perspective, there will be four total solar eclipses on visible from the United States in that same time. Thankfully, there were still a number of places where the Sun was shining on November 11 and observers participating in the Citizen ToM (Transit of Mercury) Project occupied a few of them.

Back in 2017, the Citizen CATE Project had over 60 observing sites collecting image data with identical equipment (Daystar telescopes and Point Grey cameras) spread throughout the path of totality during the Great American Total Solar Eclipse. The Citizen ToM (Transit of Mercury) project involved almost 20 of those same sites. The goal of the Citizen ToM Project was to use the transit to reenact the technique, developed by Sir Edmund Halley, for measuring the distance from the Earth to the Sun. In astronomy circles, we refer to the average distance between these two bodies as the Astronomical Unit (AU). Without knowing how long an AU is, astronomers would only know the relative sizes and distances between objects. Even during Halley's time, the actual length of the AU remained unknown despite its importance in helping us understand the true size and scale of our Solar System.

Aligning images and then subtracting one from the other highlights how much Mercury's position shifted due to parallax, as seen in this zoomed-in comparison of images taken by Peter Nguyen (Hartsville, South Carolina – a Lunt solar wedge site) and Matt Penn (Tucson, Arizona).

The principles behind Halley's technique are simple. When either Mercury or Venus passes in front of the Sun, observers in different locations on Earth will see the planet's silhouette in slightly different positions due to parallax. Measure how much the planet's apparent position shifts, and then we can do the math to calculate the distance from Earth to Mercury or Venus. One more step of algebra will lead you to the Earth–Sun distance. The

A composite shows Mercury passing across the face of the Sun throughout the morning of November 11, 2019. Images by Julia Kamenetzky and students

technique works best when the two observing sites are far apart.

In 1716, Halley published the details of his method based on the idea of using a transit of Venus. He died before the next transit of Venus in 1761. Several European nations sent expeditions around the globe to observe the 1761 transit of Venus and measure the AU, in what has been called possibly the first international scientific project in human history. Weather and wars hindered many of the expeditions for both the 1761 and 1769 transits of Venus.

Astronomers soon moved on to other techniques and have known the length of the AU for well over a century now. However, Halley's technique is still valid and there are not many opportunities to reenact historic measurements in astronomy – especially for students.

And so it was that on November 11, 2019, approximately 20 observing sites across the country, many of which were schools, prepared to take simultaneous images of Mercury as it passed in front of the Sun. About half of those sites were clouded out. Lynn Powers (Montana) and Maryanne Angliongto (Missouri) reported nothing but snow-filled skies. Several international observers heard about the project and volunteered to participate (with different equipment) and share their data. Alas, clouds also struck in Switzerland and southern Argentina.

Bob Bear (Southern Illinois University) and his students simply made the best of it: "We were clouded out completely here… but we still made a nice morning out of the ToM observations. We kept the scope tracking and ready to image while we watched online pics of the transit in progress and told stories about past transits and eclipses."

In many places, the skies teased observers with maybe-I'll-be-cloudy-and-maybe-I-won't. Some members of the Citizen ToM Project hit the road. Richard Lighthill (La Pine, Oregon) drove 45 miles at the last minute to escape the fog. He was able to find a spot, take a guess at a polar alignment, and wait for a clearing. "The Sun would only peek out very occasionally and even then it was through thinner fog… I missed most of the early timings but was able to catch the egress of Mercury! Then… nothing but thick clouds over the Sun!" Lighthill said.

Mike Conley (Salem, Oregon) chose to stay put and take other action. He did "some tree trimming to ensure an unobstructed view for the entire event." Thankfully, the skies stayed mostly clear for much of the event and improved throughout the morning. Not all were so fortunate. Conley related that "People [in the Salem astronomy club] more than a few miles east of me were not only largely clouded out but some reported some rain during the transit! I was very lucky indeed."

Conley and Lighthill both proved to be key observers. Not only were they the westernmost ToM members, they were also using Herschel solar wedges. One of the biggest challenges for Citizen ToM was the ability to accurately align images from multiple locations. The Sun does not have fixed surface features to serve as alignment points, but it has sunspots – sometimes. The timing of the 2019 transit of Mercury was rather unfortunate. The planet was near perihelion and so its position would shift less due to parallax than if Mercury were in a different part of its orbit around the Sun. It also turned out that the transit would be only days away from solar minimum – the bottom of the sunspot cycle. During the 100 days leading up to the day of the transit, official data showed that 90 were spot-free and most of the sunspots that were seen were *very* small.

Knowing that there would probably not be sunspots visible on the day of the transit, we would have to rely on patterns in the granulation and surface texture of the Sun for alignments. The ideal solution is to image in either H-alpha or even Calcium-K wavelengths, but that was too pricey. Enter the solar wedge.

Lunt Solar Systems generously donated four white light solar wedges to the Citizen ToM Project so that we could capture as much surface detail as possible. Solar wedges are essentially highly specialized diagonals that can be used with refracting telescopes without a traditional solar filter. Most of the

SCC-Conley

Baseline Distance	3374.77
Dist between Mercuries (pixels)	5
Diameter of Sun's Image (pixels)	1363
Mercury Elongation (degrees)	20.1
Sun's Apparent Diameter (arcminutes)	32.3
Actual AU (km)	149,597,871

Mercury-> Sun Dist	0.343659695
Sun's Apparent Diameter (degrees)	0.538333333
Calculated Paralla:	0.00197481
Tan(parallax)	3.44669E-05
Dist between Earth & Mercury (km)	97,913,233.18
Measured AU (km)	149,180,588.75

Screenshot of the results of the calculations for measuring the AU based on images by Conley and Stockbridge incoming energy is directed towards a ceramic heat sink. The small amount of light not sent to the heat sink passes through a neutral density filter to bring the image down to safe viewing levels. The result is the best, most detailed white light view of the Sun possible. Two of the Lunt wedges went west and two went east to the Carolinas.

Capturing the data was fairly straightforward. At predetermined times, each observer would take a 10-second video of the Sun's full disk. They would then stack the video into a single image for future processing. At the end of the day, everyone uploaded their image files. The transit started before sunrise for most of the United States, and so the most important observing times took place near the end of the transit – when the Sun was as high as possible for the western sites.

Although half of the ToM sites were clouded out, ten sites were able to acquire images at the last scheduled time and the data is promising. There were no sunspots on the day of the transit, as expected. However, several small faculae were consistent in many of the images and could be used for image alignment. Blinking back and forth between images clearly showed Mercury's apparent position changing even at locations that were relatively close together. As expected, the shift was greater the more widely spaced the observing sites were.

The students who were involved in Citizen ToM knew this was coming but still learned far more than they bargained for. All were excited about using the Daystar telescopes and taking astronomical images – usually for the first time. All experienced a thrill at seeing Mercury in front of the Sun because they understood what was happening right in front of them and what *their* data would be used for. That's where their learning began, but not where it ended.

Julia Kamenetzky (Salt Lake City, Utah) was the only ToM site able to collect data in the Rocky Mountains, but she revealed that students' eyes were opened to the importance of communication in science. Her team consisted of "a group of seven physics students, with no previous astronomy or telescope experience. They helped nearly sixty people from the Westminster College community safely observe the transit and explained our experiment to scientists and non-scientists alike.... I am very proud of our students for learning how to use the equipment and explain the experiment to others. I think many of them did not previously realize how difficult it can be to condense and simplify a scientific experiment to explain to the public, but I know they will take this new skill with them into their future research work."

Students and the public gather around a small fleet of telescopes at Los Alamos High School (New Mexico). Photo by Galen Gisler

Many ToM observing sites hosted public viewing events in addition to collecting data. At Los Alamos High School (New Mexico), Galen Gisler stated that "for the high school astronomy club, the event was a huge success in terms of outreach. Some of the students took charge of a 4-inch Meade [Schmidt–Cassegrain] that belongs to the Los Alamos Nature Center, and were using it to help educate the public." The story was the same for Matt Cass and me at Southwestern Community College in Sylva, North Carolina, where we oversaw a small fleet of telescopes and had close to 200 visitors throughout the morning.

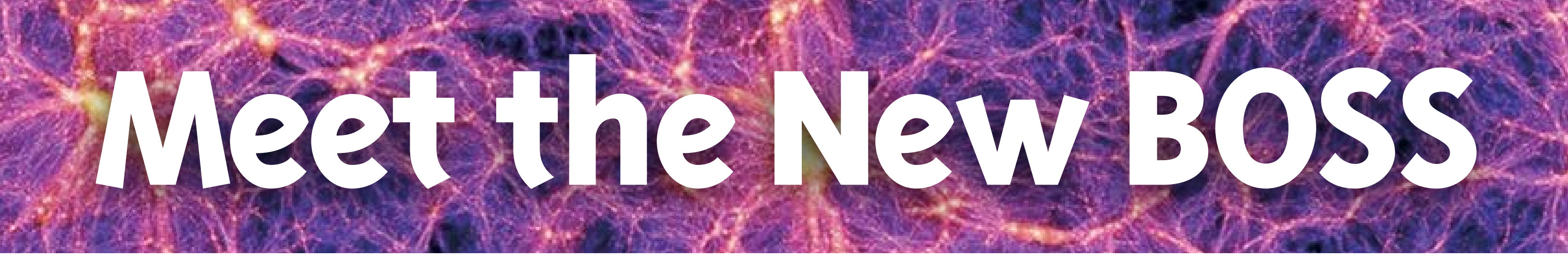
So aside from positive experiences, what are the results? A comparison of images taken by Conley (Salem, Oregon) and me (Sylva, North Carolina – one of the eastern solar wedge sites) shows a slight shift in Mercury's position. How slight? The cameras produced images 1538 pixels by 1538 pixels. Each pixel is 3.45 microns on a side. Mercury shifted by a mere five pixels. Jumping through the math yields a value of the AU of 149,200,000 km. This is a mere 0.28% from the accepted value!

In addition to using Halley's technique, we are working on additional ways to analyze the data and measure the AU. One method involves using precise timings of third contact (the moment when Mercury's disk touches the edge of the Sun and begins moving off of it). The most intriguing possibility uses composite images. Many people make composites that show Mercury's position throughout the transit. Every location on Earth saw Mercury in a slightly different position due to parallax, but all of the paths will be parallel to each other. Doing a line-of-best-fit through all of the Mercurys from an observing site, shifting the image and then rotating it so that the line is parallel to that of a different observing site should serve as something of an impromptu alignment. Calculating the rate at which Mercury moves across the image allows you to extrapolate the silhouette's location at any given second. The end result is that any composite image could be used to measure the AU – even if the original observations were not simultaneous.

The Citizen ToM Project used identical equipment and this made the analysis easier. However, careful resizing of the images and the procedure described above would allow images taken at *any* time with *any* equipment to become useful and yield accurate results. Fully developing and implementing these techniques will take some time. For now, we are quite happy with the early results and the experience that students across the country had in collecting astronomical data for themselves and following in Halley's footsteps. ★

Zack Stockbridge was the Citizen ToM project lead and is very much looking forward to more activity in the new sunspot cycle.

Meet the New BOSS



This graphic represents a large supercluster system, like the BOSS Great Wall, with its clusters, voids, and galaxy filaments. (Cropped from illustration by Volker Springel, Max Planck Institute for Astrophysics)

BY DAVE TOSTESEN

I went ahead without the facts, knowing a window of opportunity was closing…

…I wanted to observe a discovery, but had not received details about its members. This was the largest and most massive collection of galaxy clusters ever found, and its light had been traveling toward us since before the Solar System formed, so I couldn't wait. With winter approaching and the Moon making an entrance, I decided to observe first and sort it out later.

Philip and Phylis Morrison's book *Powers of Ten* displays an elegant step-like hierarchy of size in the natural world. Some of its divisions are readily understandable given our present knowledge, such as how electrons orbit the nuclei of atoms, or planets their stars.

Others are less clear and open to interpretation. At the largest scales are superclusters of galaxies that span tens of millions to over a billion light-years in diameter. Dedicated astronomers are piecing together their distribution, architecture, and history. Over the last several decades, a sponge-like system of voids has been discovered, whose hypodense regions of space also range to a billion light-years across. They are surrounded by strings and clusters of galaxies collected and connected on their periphery where gravity, dark matter, and the expansion of the Universe work to form what is called the cosmic web.

Superclusters of galaxies are the largest coherent single structures we define, and they form at the intersections of voids. Richard Powell's evocative website *Atlas of the Universe* mirrors the Morrisons' format, and his two diagrams of "Nearest" and "Neighboring" superclusters give succinct visual representation to these diametric densities. Astronomers seeking ways to fit these collections of galaxies into presently understood cosmic structure may find the Universe dealing its usual response to categorizers: unexpected, confounding, and delightful discrepancies. It seems the Cosmos savors beguiling us by revealing only slivers of its complexity, as we strive to make tapestry from threads. If we look outward from our home galaxy, we see how some of this structure is arranged.

We are part of a relatively sparse collection of sixty to eighty galaxies called the Local Group (LG). In the first decade of imaging, the Sloan Digital Sky Survey (SDSS) added many Ultrafaint Dwarf Galaxies (UDGs) such as Segue 1 to our local census. These are the smallest and faintest galaxies known, often consisting of only hundreds to a few thousand stars, and containing mostly dark matter. Before their discovery I had observed all but seven of the known fifty-four Local Group galaxies. A planned trip to the Atacama Desert of Chile may help complete my observed list of these "classic" LG members. For the newly found, faintest UDGs, only individual stars between 18th and 20th magnitude have been detectable in the eyepiece, as outlines of the whole galaxies are not visible.

Our Local Group is gravitationally dominated by the Milky Way and the Andromeda Galaxy, located 2.5 million light-years away. There have been uncounted myriad interactions between galaxies within the Local Group over billions of years, and these two have grown largest by cannibalizing many dwarf galaxies, manifested in the stellar streams seen in long-exposure images, and star counts such as those found by GAIA. Most galaxies in the Universe are part of modest collections similar to our Local Group.

Toward the constellation Virgo lies a much larger cluster of galaxies containing over two thousand members. This Virgo Cluster is the heart of the Virgo Supercluster, which comprises over a million billion solar masses in at least one hundred groups stretched over a diameter of 110 million light-years. Our Local Group is at one edge and the three giant ellipticals Messiers 87, 86, and 84 are at its center. Other well-known collections within it include the M81 group, the Ursa Major I and II groups, and those of M66, M101, and M51. Over two decades I have observed several thousand galaxies in this supercluster.

In 2014 the Virgo Supercluster was determined by Brent Tully and his colleagues to be part of a larger supercluster named Laniakea, Hawaiian for "immeasurable Heaven." This immense structure spanning half a billion light-years was defined by its gravitational domain and is just one of millions of superclusters in our Cosmos. Early researchers such as George Abell documented thousands of galaxy clusters, and recognized that connections and associations existed between them. His two-dimensional sky was teasing us. We needed a third dimension to reveal the poriferal pattern.

In the 1980s, Margaret Geller and the late John Huchra of the Harvard Center for Astrophysics (CfA) headed a team that performed a deep-redshift galaxy survey in hope of adding depth to the sky.

In 1989 Geller and Huchra announced the discovery of the largest structure known at the time: a filament of apparently connected clusters and superclusters of galaxies along a 500 by 200 million light-year-long area just 15 million light-years thick. It was dubbed the "Great Wall," with the prefix "CfA" soon added. In the early 1990s my friend Dennis Webb researched this wall and inspired me to observe a number of its galaxy clusters and superclusters. Two decades later he and Jeff Kanipe have been producing *Annals of the Deep Sky,* a constellation-based series of reference books that will be an amateur standard for decades. At the end of each chapter they provide diagrams extending our view outward to groups of galaxies from sources such as Brent Tully's *Nearby Galaxies Atlas*, and toward local superclusters from Maret Einasto's work at Estonia's Tartu Observatory.

Abell 2151 is a rich galaxy cluster in Hercules half a billion light-years away. It is part of a structure that connects to the

Coma Supercluster containing two major galaxy clusters, Abell 1367 in Leo and Abell 1656 in Coma Berenices. The latter is the central member and densest portion of the CfA Great Wall. I have an ongoing observing project over the last few years to view galaxies within the central square degree of Abell 1656. During seventy hours of observing I have seen 700 galaxies to nearly 20th magnitude, covering two-thirds of the field.

One challenge is to identify membership for individual galaxies, as published catalogs go no fainter than 18th magnitude. Some of these galaxies may be background objects, but I think many could be dwarfs within the cluster, especially in light of the recent deep imaging showing a likely continuum of size and brightness within this class. The whole of AGC 1656 encompasses 25 square degrees, and likely contains over five thousand galaxies.

A decade and a half after Geller and Huchra, a Sloan Digital Sky Survey team headed by Princeton's J. Richard Gott III announced an even larger structure of a similar nature. His group termed it the "Sloan Great Wall." It was 1.4 billion light-years in length and located a billion light-years from us. Numerous studies deciphered details which I used to locate and view some of its galaxies. It held the title of largest galaxy wall for a decade until the somewhat controversial "Hercules-Corona Great Wall" was announced in 2013.

In the intervening years astronomers found collections of high-redshift quasars and gamma-ray bursts from the early Universe thought to outline cohesive structures interpreted as forerunners of galaxy superclusters. If confirmed, these "large quasar groups" would wrest the title of largest structure. Since everything is likely connected, as are highways or vessels in our body, the issue of what is largest may be ultimately moot, similar to which black line on the basketball is longest. Discussions in the literature reference the debate which came first: supermassive black holes (SMBHs) with their attendant quasars, or growing galaxies that would later produce them? The findings of SMBHs in small dwarf galaxies such as Henize 2-10 and the twelve billion solar-mass behemoth at the center of a high-redshift (6.30) quasar suggest the former may be true. Were it so, it would support the recent direct collapse formation theory of black holes with over a million solar masses.

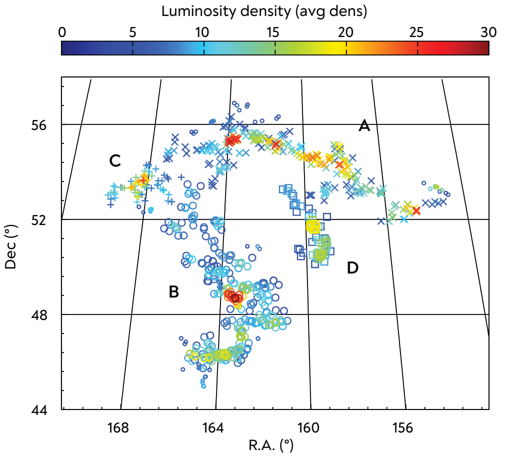
In February 2016, Heidi Lietzen (Instituto de Astrofísica de Canarias, Tenerife, Spain) and her team announced discovery of a massive supercluster system. Located between the legs of the Great Bear in Ursa Major, it carried a redshift of 0.47, with a light travel time of 4.9 billion years. Searching the SDSS database, they studied this complex of galaxies stretching over a billion light-years in diameter and holding 2×10^{17} solar masses. This would make it the most massive system of superclusters known in the Universe. Split into four "cores" in their arXiv paper (1602.08498v1, 26 February 2016), the B core had the highest maximum density and held over a third of the system's 830 identified galaxies.

They estimated there were thousands more galaxies present in the structure that either did not fit their criteria for study or could not be identified at the nearly five billion light-year distance of the system. The shape of this system diagrammed in their paper resembled the outline of the Herdsman's body in the adjacent constellation Boötes. If one ignores the Herdsman's outstretched arm, the projected sizes of the two structures on the sky are coincidentally close, despite the supercluster system being 100 million times more distant. No one could resist the temptation to name it after the source of the data, the Baryonic Oscillation Spectroscopic Survey, dubbing it the BOSS Great Wall (BGW).

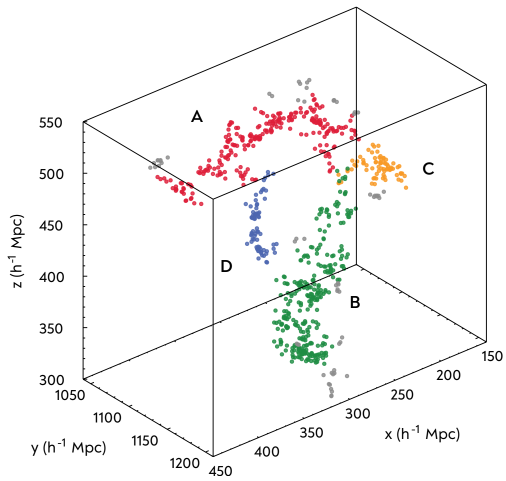
By 2016 there was only one paper on the subject, and its list of galaxy coordinates had not yet been made available to me when I observed the area. Close inspection of figure 3 in the paper suggested the area centered on 10h 52.8m, +48d 40m within the B core was one of its densest collections of galaxies. A POSS 2 red plate image 15 arcminutes square centered there showed dozens of small, faint galaxies I assumed were members of the wall. I was partially right. Of the forty to fifty faint galaxies in the field, it would turn out that only a handful were designated BGW members on the list provided by the author a few days after my observations. But there was more to the tale.

The morning of November 11, 2016, presented excellent conditions at my home in Minnesota for observing the BOSS Great Wall. The waxing gibbous Moon had set at three o'clock but would soon be an end-whistle minimizing dark-sky study until the next lunation. From my home in central Minnesota, weather often precludes observing from December until March, a strong factor in the decision to observe without all the data. The region was 70 degrees up, with no humidity and excellent seeing and transparency.

The temperature hovering below 40 degrees at 4 a.m. spurred on the observations but did not interfere. This fifteen-arcminute square area around the above coordinates, with its extremely faint galaxies, was challenging to observe in my 32-inch f/4 reflector. The targets had no known magnitudes, but I estimated they were 18.0 to 19.5 based on nearby comparison stars. Twenty



Galaxies in the BOSS Great Wall (BGW) in sky coordinates. The color scale shows the local environmental density in terms of mean densities for each galaxy. The different symbols refer to galaxies in the four largest superclusters in the system determined with the density threshold D>6.



Galaxies in theBGW superclusters in Cartesian coordinates. Different colors show the individual superclusters in the BGW system.

Diagrams courtesy of Heidi Lietzen, from the paper referred to in the text above.

galaxies in the field were viewed over eighty minutes, using mostly 650x. The following morning produced a sky less conducive with colder temps, so only eight more were added, for a total of twenty-eight galaxies seen over two and a half hours of viewing. The SDSS image has enhanced resolution over the POSS, and designates which objects have spectra. Areas on both these images show strings and clusters of apparent galaxies and I wondered why, with so many present in a small portion of the wall, less than a thousand were procured in the full study. The head of the project would offer the explanation.

Lead author Heidi Lietzen graciously responded to my request for BGW galaxy coordinates, sending all 830. I compared them to my observations and was disappointed when only a few of my twenty-eight galaxies correlated. She provided the reason for this variance in private communication, explaining there were three criteria for inclusion in the spectroscopic study: colors that maximized redshift accuracy, brightness, and spacing between galaxies. The last was a physical limitation of how close the fiber optic cables that produce the spectroscopy could be to each other. With their equipment it was one arcminute. There was an SDSS spectrum for the object I termed “B489” in my numbering system of the 830 galaxies in the file Dr. Lietzen sent. Its coordinates are 163.200272 (RA), +48.7024612 (Dec). Many proximate objects, including an apparent cluster of ten galaxies 20 to 30 arcseconds to its southwest, did not have spectra because of the fiber optic cable spacing requirements. This explanation about why such tightly packed regions were not included on the spectroscopic study offered me encouragement about the effort to observe them, understanding their status as yet to be determined.

Because of these limitations she stated, “they are certain there are (many) more galaxies in the walls than these 830.” I was able to see five or six times more galaxies in the above field than what were attributed to the BGW, and that image contained three or four times the number of faint galaxies I could see in the eyepiece. Taking into consideration the area examined was one of the wall’s densest portions, and that some of its objects are likely unassociated “field” galaxies, my very rough estimate is the “true” BOSS Great Wall may hold several tens of thousands of galaxies. This does not seem overgenerous given the census of structures such as Abell 1656. If we step back to look at the larger structure of interconnecting elements in the cosmic web, then even the BOSS Great Wall could be a paltry ten-lane stretch of freeway, town-sent and contiguous with the system of roads that bind the whole.

As I did with visual observing projects for the Coma Cluster, AGC 426 in Perseus, and the Sloan Great Wall, I carved off a piece of the BGW to observe. Extrapolating to a larger dataset to estimate what part of the whole is potentially visible appears a reasonable compromise between effort, time and completeness. Perhaps an ambitious future amateur will choose to hike such a large project as the full BOSS Great Wall. As big as *it* is, there are likely greater walls to scale. Lietzen and other astronomers have cautioned we’ve seen only a quarter of the sky with the SDSS, and future projects will dwarf its database. Planned observatories in the next decade such as the Large Synoptic Survey Telescope will greatly add to information about large-scale structure in the Universe. This 8.4-meter, extremely wide-field instrument currently under construction in Chile will survey its available sky every few nights to 23rd magnitude. It and others will revolutionize knowledge while further precluding visual mastery in the sense of being able to see all the individual members. Amateur observers will need to choose from a wealth of objects to study in an exponentially growing database. I might compare it to the difference I experienced between snorkeling within the Great Barrier Reef and its incomparable view from my window on the flight from Brisbane to Cairns.

Opinions change with perspective, and we learn from choices. Amateurs and professionals who creatively explore and define our Universe ardently wish for a deeper understanding of both our journey and our address. Curiosity can take us into dark alleys and dead ends, and learning from them enlightens us so we won’t get fooled again.

We have awakened
And our dream is real

★

Reference: Lietzen et al. (2016) Discovery of a massive supercluster system at z~0.47. A & A 588: L4. Preprint available at arxiv.org/abs/1602.08498.

ALCON 2020

July 16 – 18

EMBASSY SUITES HOTEL

1000 Woodward Pl. NE
Albuquerque, New Mexico 87102
https://alcon2020.astroleague.org/

Hosted by:

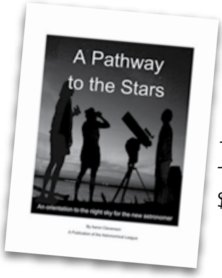
The Albuquerque Astronomical Society

www.TAAS.org

ONE-STOP ASTRONOMY SHOPPING

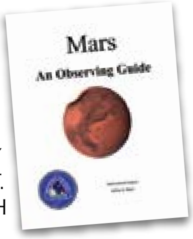
store.astroleague.org

The Astronomical League online store utilizes secure shopping cart technology and accepts credit cards. Shipping & handling (S&H) is calculated at checkout. Merchandise is also available by mail order: choose your items, add the applicable S&H fee, and mail your order with check to: ***Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114***
If you have questions about the merchandise, or discounts on bulk orders, please call the League office, 816-DEEP-SKY, *or email* leaguesales@astroleague.org.

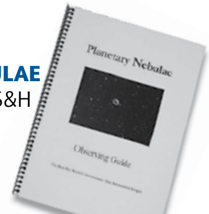


A PATHWAY TO THE STARS
THIS MANUAL IS A GREAT INTRODUCTION TO ASTRONOMY FOR THE NEW ASTRONOMER.
$10 PLUS $4 S&H

MARS – AN OBSERVING GUIDE
A SYSTEMATIC PROGRAM STUDY OF THE RED PLANET.
$18 PLUS $6 S&H



PLANETARY NEBULAE
$17 PLUS $6 S&H



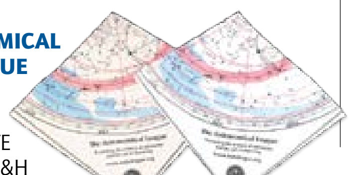
ASTRONOMICAL LEAGUE VISUAL ASTRONOMICAL OBSERVING JOURNAL
$12 PLUS $6 S&H

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

ASTRONOMICAL LEAGUE LAPEL PIN
(ONE-INCH DIAMETER)
$8 PLUS $2 S&H

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

ASTRONOMICAL LEAGUE BANDANA
NATURAL OR WHITE
$12 PLUS $2 S&H



ASTRONOMICAL LEAGUE BASEBALL HAT
EMBROIDERED LOGO, ADJUSTABLE; ROYAL BLUE, MAROON, KHAKI, NAVY;
$16 PLUS $5 S&H

ASTRONOMICAL LEAGUE SPORTSMAN'S BUCKET HAT
EMBROIDERED LOGO, ONE SIZE; KHAKI ONLY
$22 PLUS $5 S&H

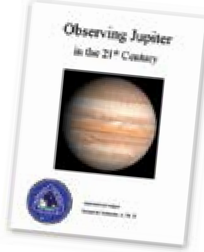
UNIVERSE SAMPLER
A JOURNEY THROUGH THE UNIVERSE FOR THE BEGINNER
$13 PLUS $5 S&H

MESSIER OBJECTS
A BEGINNER'S GUIDE
$8 PLUS $3 S&H

MATH FOR AMATEUR ASTRONOMERS
$14 PLUS $5 S&H

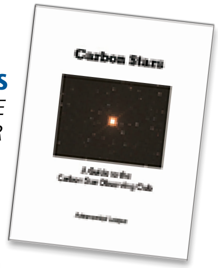
"GUIDE TO THE STARS" 16-INCH PLANISPHERE
$21 PLUS $8 S&H

ASTRONOMICAL LEAGUE TOTE BAGS
NYLON (LEFT) OR CANVAS
$12 PLUS $6 S&H



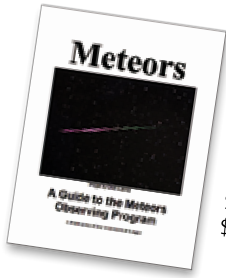
OBSERVING JUPITER IN THE 21ST CENTURY
$12 PLUS $4 S&H

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



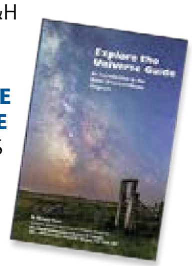
THE HERSCHEL II OBSERVING PROGRAM
$18, PLUS $7 S&H

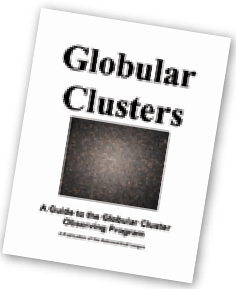
GALAXY GROUPS AND CLUSTERS
$20 PLUS $7 S&H



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

RASC EXPLORE THE UNIVERSE GUIDE
$20 PLUS $4.50 S&H





GLOBULAR CLUSTERS
$14 PLUS $5 S&H

2019 Peltier Award: Tom Reiland

The Astronomical League's 2019 recipient of the Leslie C. Peltier Award, Tom Reiland, certainly has many credits to his name.

He has been a member of the Amateur Astronomers Association of Pittsburgh for 45 years. During that time has served as president of the AAAP for 15 years and vice president for 3 years. He founded and has

served as director of the Nicholas E. Wagman Observatory since 1975.

He was co-originator of the Messier Marathon in 1975 and completed the marathon three times.

He served as vice chairman of MERAL for one year, and editor of the MERAL *Meteor* for one year. He has taught observing and Astronomy classes since 1976.

He discovered "Reiland's Cluster" (Reiland 1) in 1985 from his backyard using a homemade 8-inch f/5 Newtonian reflector. In addition, he discovered (as sole visual discoverer) and was the first to report the supernova in M51 on June 1–2, 2011, SN 2011dh.

He received Herschel Certificate No. 1 in 1981 and Messier Certificate No. 235 in 1976.

He has logged more than 153,000 observations in more than 5,700 hours over more than 45 years, totaling more than 7,500 objects.

He observed the Herschel Catalogue from 1974 through April 2017 and wrote an article about his experience that was published in the March 2019 issue of *Sky & Telescope*.

He worked at the Allegheny Observatory from 1978 through 2000 as an observer, tour guide, assistant astronomer, lecturer, and assistant senior observer, and from 1991 to 2000 he served as the senior observer.

He has received four awards from the AAAP: the George G. Lindbloom Award in 1991 for the most contributions during the previous year, the John Brashear Award for 25 years of constant volunteer work for the AAAP, an Honorary Membership for lifetime achievement, and a Special Award for his discovery of the supernova in M51 in 2011.

His motto is "I live to observe and observe to live."

It was a pleasure to present Tom Reiland with the 2019 Leslie C. Peltier award!

—Roger Kolman

Observing Awards

Advanced Binocular Double Star Observing Program

No. 34, **Robert Togni,** Central Arkansas Astronomical Society

Arp Peculiar Galaxies Northern Observing Program

No. 95-C, **John Skillicorn,** Tucson Amateur Astronomy Association

Asterism Observing Program

No. 51, **Russell F. Pinizzotto,** Southern Maine Astronomers Club; No. 52, **Paul Byrne,** Member-at-Large; No. 53, **Ken Boquist,** Popular Astronomy Club; No. 54, **Peter K. Detterline,** Member-at-Large; No. 55, **Albert E. Smith,** Member-at-Large;

Asteroid Observing Program

No. 54, **Paul Harrington,** Regular, Member-at-Large; No. 55, **David Whalen,** Regular, Atlanta Astronomy Club; No. 56, **Richard Loslo,** Regular, Member-at-Large; No. 64, **Paul Harrington,** Gold, Member-at-Large; No. 65, **Al Lamperti,** Gold, Delaware Valley Amateur Astronomers

Beyond Polaris

No. 35, **Anastasia Vail,** Raleigh Astronomy Club

Binocular Double Star Program

No. 150, **Robert J. Olsen,** Member-at-Large; No. 151, **Carl Stanley,** Member-at-Large; No. 152, **Jeff Willson,** Rose City Astronomers; No. 153, **Brad Payne,** Northern Virginia Astronomy Club

Binocular Messier Observing Program

No. 1179, **Scott Lee,** Boise Astronomical Society; No. 1180, **Scott Cadwallader,** Baton Rouge Astronomical Society; No. 1181, **Brad Walter,** Central Texas Astronomical Society; No. 1182, **Anastasia Vail,** Raleigh Astronomy Club; No. 1183, **Krista Reed,** Baton Rouge Astronomical Society

Binocular Variable Star Observing Program

No. 36, **Charles E. Allen,** Evansville Astronomical Society; No. 37, **W. Maynard Pittendreigh,** Brevard Astronomical Society; No. 38, **Rob Ratkowski,** Haleakala Amateur Astronomers

Bright Nebula Observing Program

No. 14, **Roy Troxel,** Member-at-Large

Caldwell Observing Program

SILVER AWARDS

No. 263, **Kristopher Setnes,** Minnesota Astronomical Society; No. 264, **Jeff Willson,** Rose City Astronomers; No. 265, **Antone Gregory,** Minnesota Astronomical Society

Carbon Star Observing Program

No. 105, **Jeffrey S. Moorhouse,** La Crosse Area Astronomical Society

Citizen Science

No. 1, **Michael A. Hotka,** Observational Bronze, NEO, Longmont Astronomical Society; No. 1, **Michael A. Hotka,** Observational Silver, NEO, Longmont Astronomical Society; No. 1, **Michael A. Hotka,** Observational Gold Class 1, Variable Stars, Longmont Astronomical Society; No. 1, **Al Lamperti,** Active Gold Class 3, Galaxy Zoo Clump Scout, Delaware Valley Amateur Astronomers; No. 1, **Al Lamperti,** Active Gold Class 11, Planet Four Terrains, Delaware Valley Amateur Astronomers; No. 1, **Brad Young,** Active Bronze, Galaxy Zoo, Astronomy Club of Tulsa; No. 1, **Brad Young,** Observational Silver, Variable Star, Astronomy Club of Tulsa; No. 1, **Brad Young,** Observational Gold Class 1, Nova, Astronomy Club of Tulsa; No. 1, **Brad Young,** Observational Gold Class 2, NEO, Astronomy Club of Tulsa; No. 1, **William Clarke,** Observational Gold, Class 3, Variable Star, Tucson Amateur Astronomy Association; No. 1, **William Clarke,** Observational Gold, Class 6, Binocular Variable Star, Tucson Amateur Astronomy Association; No. 1, **Russell F. Pinizzotto,** Active Bronze, Galaxy Zoo, Southern Maine Astronomers; No. 1, **Russell F. Pinizzotto,** Active Bronze, Galaxy Zoo Clump Scout, Southern Maine Astronomers

Comet Observing Program

No. 46, **Keith Davidson,** Gold, Member-at-Large

Constellation Hunter Observing Program (Northern Skies)

No. 233, **Russell F. Pinizzotto,** Southern Maine Astronomers; No. 234, **Carl Stanley,** Member-at-Large; No. 235, **Jeff Willson,** Rose City Astronomers; No. 236, **Linda Hoffmeister,** Olympic Astronomical Society; No. 237, **Daniel Beggs,** Member-at-Large; No. 238, **Rick Eberhart,** Rose City Astronomers; No. 239, **Antone Gregory,** Minnesota Astronomical Society

Dark Nebulae Observing Program

No. 29, **David M. Douglass,** East Valley Astronomy Club

Dark Sky Advocate

No. 16, **Rodney R. Rynearson,** St. Louis Astronomical Society

Deep Sky Binocular Observing Program

No. 410, **Gus Gomez,** Tucson Amateur Astronomy Association; No. 411, **Rene Scandone Gedaly,** Houston Astronomical Society

Double Star Observing Program

No. 638, **Scott Lee,** Boise Astronomical Society; No. 639, **Wayne E. Frey,** Imperial Polk Astronomical Society; No. 640, **Carl Stanley,** Member-at-Large; No. 641, **Jeff Willson,** Rose City Astronomers; No. 642, **Albert E. Smith,** Member-at-Large

Galaxy Groups and Clusters Observing Program

No. 41-DA, **Peter K. Detterline,** Member-at-Large; No. 42-DA, **John Sikora,** Member-at-Large; No. 43-DA, **Rodney Rynearson,** St. Louis Astronomical Society; No. 44-M, **Peter Natscher,** The Astronomy Connection

Galileo Observing Program

No. 54, **Peter Detterline,** Binocular, Member-at-Large; No. 55, **Jonathan Poppele,** Binocular, Minnesota Astronomical Society; No. 56, **Mark Bailey,** Binocular, Member-at-Large; No. 57, **Scott D. Cadwallader,** Binocular, Baton Rouge Astronomical Society; No. 58 **Aaron Clevenson,** Binocular, North Houston Astronomy Club

Globular Cluster Observing Program

No. 331-V, **Joe Timmerman,** Minnesota Astronomical Society; No. 332-V, **Doug McCormick,** Houston Astronomical Society; No. 333-V, **Sam Finn,** Central Pennsylvania Observers; No. 334-V, **Lauren Rogers,** Escambia Amateur Astronomers Association; No. 335-V, **Daniel Carey,** Seattle Astronomical Society; No. 336-V, **Peter Natscher,** The Astronomy Connection; No. 337-I, **Mark L.**

Mitchell, Delaware Astronomical Society; No. 338-V, **Brad Payne,** Northern Virginia Astronomy Club; No. 339-V, **Jarret Lingle,** Mason Star Gazers

Herschel 400 Observing Program

No. 614, **Brad Payne,** Northern Virginia Astronomy Club; No. 615, **Kim Balliett,** Richland Astronomical Society; No. 616, **Robert Harrison,** Member-at-Large; No. 617, **Glen Winn,** Texas Astronomical Society; No. 618, **Antone Gregory,** Minnesota Astronomical Society

Herschel Society

No. 9, **Bruce Scodova,** Silver, Richland Astronomical Society; No. 10, **John Neuman,** Silver, Richland Astronomical Society

Local Galaxy Groups and Galactic Neighborhood Observing Program

No. 43-DA, **Jack Fitzmier,** Member-at-Large; No. 44-DA, **Chuck Allen,** Louisville Astronomical Society

Lunar Observing Program

No. 1077, **Dave Eberle,** Spokane Astronomical Society; No. 1078, **Mike Grabner,** Rose City Astronomers; No. 1079, **Brad Payne,** Northern Virginia Astronomy Club; No. 1080, **Steven Goldberg,** Houston Astronomical Society; No. 1081, **James Paciello,** Smoky Mountain Astronomical Society; No. 1082 and No. 1082-B, **Ron Ziss,** Naperville Astronomical Association; No. 1083, **Bill Young,** Big Bear Valley Astronomical Society; No. 1084, **James F. Petruzzi,** Haleakala Amateur Astronomers; No. 1085, **Anastasia Vail,** Raleigh Astronomy Club; No. 1086, **Krista Reed,** Baton Rouge Astronomical Society; No. 1087, **Laurie Ansorage,** Member-at-Large; No. 1088, **Glynn Germany,** Rio Rancho Astronomical Society; No. 1089, **Ray Kiddy,** Cumberland Astronomy Club

Lunar II Observing Program

No. 102, **Edgar G. Fischer,** Albuquerque Astronomical Society

Lunar Binocular Observing Program

No. 864-B, **Glenn Wolford,** Member-at-Large

Messier Observing Program

No. 2822, **Donald R. Bates,** Honorary, Texas Astronomical Society of Dallas; No. 2823, **Benjamin Burnett,** Honorary, Albuquerque Astronomical Society; No. 2824, **Michael R. Martin,** Honorary, Roanoke Valley Astronomical Society; No. 2825, **Don Bradford,** Honorary, Astronomy Club of Tulsa; No. 2826, **Johnney Ehrlich,** Regular, Mason Star Gazers

Meteor Observing Program

No. 189, **David Whalen,** 24 hours, Atlanta Astronomy Club; No. 197, **Brad Payne,** 6 hours, Northern Virginia Astronomy Club; No. 198, **Jesse Roberts,** 6 hours, North Houston Astronomy Club

Multiple Star Observing Program

No. 1, **Terry Trees,** Amateur Astronomers Association of Pittsburgh

NASA Observing Challenge – Mercury Transit

Aaron Clevenson, North Houston Astronomy Club; **Rick Eberhart,** Rose City Astronomers; **Jim Kaminski,** Member-at-Large; **Jim Michnowicz,** Raleigh Astronomy Club; **Adrian Stewart Newland,** High Desert Astronomical Society; **W. Maynard Pittendreigh,** Member-at-Large; **Nicole Sharp,** Cumberland Astronomy Club; **John Zimitsch,** Minnesota Astronomical Society

Transit of Mercury Special Observing Award

Daniel Beggs, Member-at-Large; **Robert Beuerlein,** Back Bay Amateur Astronomers; **Steve Boerner,** Member-at-Large; **John Brueggemann,** Northeast Florida Astronomical Society; **Aaron Clevenson,** North Houston Astronomy Club; **Peter Detterline,** Member-at-Large; North Houston Astronomy Club; **William T. Geertsen,** Southwest Florida Astronomical Society; **Vincent Giovannone,** Member-at-Large; **Jeff Goldstein,** Member-at-Large; **David T. Jarkins,** Springfield Astronomical Society; **István Mátis,** Member-at-Large; **Jim Michnowicz,** Raleigh Astronomy Club; **Brad Nasset,** Minnesota Astronomical Society; **W. Maynard Pittendreigh,** Member-at-Large; **Alan Sheidler,** Popular Astronomy Club; **Bird Taylor,** Back Bay Amateur Astronomers; **Robert Trebilcock,** Delaware Valley Amateur Astronomers; **David Wood,** Astronomical Society of Eastern Missouri; **James E. Wood,** Kern Astronomical Society; **Brad Young,** Astronomy Club of Tulsa; **James Zappa,** Member-at-Large; **John Zimitsch,** Minnesota Astronomical Society

Nova Observing Program

No. 7, **Dan Crowson,** Gold, Astronomical Society of Eastern Missouri

Open Clusters Observing Program

No. 102, **Peter Detterline,** Advanced Imaging, Member-at-Large

Outreach Observing Program

No. 612-S, **James Zappa,** Member-at-Large; No. 741-S, **Bridget Langdale,** Hill Country Astronomers and Mason Star Gazers; No. 827-M, **Keith Montz,** Fort Bend Astronomy Club; No. 933-S, **Jon Thomas,** Indiana Astronomical Society; No. 1042-M, **Johnny Scarborough,** Central Texas Astronomical Society; No. 1046-S, **Steve Johnson,** Big Bear Valley Astronomical Society; No. 1116-S, **Raymond Whatley,** Northeast Florida Astronomical Society; No. 1130-S, **Sam Finn,** Central Pennsylvania Observers; No. 1164-O, **Brad Payne,** Northern Virginia Astronomy Club; No. 1165-O, **John Hodgson,** Fort Bend Astronomy Club; No. 1166-O, **Gary Dietz,** Astronomy Enthusiasts of Lancaster County; No. 1167-O, **Laurie V. Ansorge,** Member-at-Large; No. 1168-O, **Jeff Baldwin,** Stockton Astronomical Society; No. 1169-O, **Michael Grabner,** Rose City Astronomers; No. 1170-O, **Johnny Barton,** Central Texas Astronomical Society; No. 1171-S, **Clark**

Williams, Temecula Valley Astronomers; No. 1172-O, **Russell F. Pinizzotto,** Southern Maine Astronomers; No. 1173-O, **Keith Wimmer,** Roanoke Valley Astronomical Society; No. 1174-M, **Robert Brayton,** North Houston Astronomy Club; No. 1175-O, **Michael Comeaux,** North Houston Astronomy Club; No. 1176-O, **Jesse Roberts,** North Houston Astronomy Club; No. 1177-O, **Ed Fraini,** North Houston Astronomy Club; No. 1178-S, **Joana Tan,** North Houston Astronomy Club; No. 1179-S, **David Dutschmann,** North Houston Astronomy Club; No. 1180-O, **Cliff Hersein,** North Houston Astronomy Club; No. 1181-S, **Benjamin Dutschmann,** North Houston Astronomy Club; No. 1182-S, **Carlos Gramajo,** North Houston Astronomy Club; No. 1183-O, **Tom Palmer,** Stockton Astronomical Society; No. 1184-O, **Robert Rubendunst,** Champaign-Urbana Astronomical Society; No. 1185-O, **Charles Fry,** Astronomy Enthusiasts of Lancaster County; No. 1186-O, **Marco Ortega,** Stockton Astronomical Society; No. 1187-O, **Richard Wheeler,** Northeast Florida Astronomical Society; No. 1188-O, **Adrian Newland,** High Desert Astronomical Society

Planetary Nebula Observing Program

No. 80, **Ken Boquist,** Advanced, Popular Astronomy Club

Sketching Observing Award

No. 38, **Rob Ratkowski,** Haleakala Amateur Astronomers; No. 39, **David Whatley,** Northeast Florida Astronomical Society

Solar System Observing Program

No. 152-B, **Charles E. Allen,** Evansville Astronomical Society

Stellar Evolution Observing Program

No. 73, **Jeff Hoffmeister,** Olympic Astronomical Society; No. 74, **Kathy Machin,** Astronomical Society of Kansas City; No. 75, **Jeff Willson,** Rose City Astronomers

Two in the View Observing Program

No. 37, **Charles E. Allen III,** Evansville Astronomical Society; No. 38, **W. Maynard Pittendreigh,** Brevard Astronomical Society

Universe Sampler Observing Program

No. 139, **Kevin McKeown,** Telescope, Member-at-Large; No. 140, **Jeff Willson,** Telescope, Rose City Astronomers; No. 141, **Carl Stanley,** Telescope, Member-at-Large

Urban Observing Program

No. 199, **Yu-Hang Kuo,** Seattle Astronomical Society; No. 200, **Dale Eason,** Minnesota Astronomical Society; No. 201, **Gus Gomez,** Tucson Amateur Astronomy Association; No. 202, **David P. Rudeen,** Etna Astros; No. 203, **Charles E. Allen,** Evansville Astronomical Society; No. 204, **Lisa Wentzel,** Twin City Amateur Astronomers

MASTER OBSERVER PROGRESSION

Observer Award

Charles E. Allen, Evansville Astronomical Society; **Mark G. Bailey,** Member-at-Large; **Vincent M. Giovannone,** Member-at-Large; **Jeffrey S. Moorhouse,** La Crosse Area Astronomical Society; **Brad Payne,** Northern Virginia Astronomy Club;

Master Observer Award

No. 227, **Larry Farrington,** Mt. Shasta Star Gazers; No. 228, **Edgar J. Fischer,** Albuquerque Astronomical Society; No. 231, **Edgar J. Fischer,** Albuquerque Astronomical Society; No. 233, **Antone G. Gregory,** Minnesota Astronomical Society; No. 229, **Bill Hennessy,** Neville Public Museum Astronomical Society; No. 232, **Linda Hoffmeister,** Olympic Astronomical Society; No. 236, **Carl Stanley,** Member-at-Large; No. 230, **Joe Timmerman,** Minnesota Astronomical Society; No. 235, **Bernard Venasse,** Member-at-Large; No. 234, **Jeff Willson,** Rose City Astronomers

Advanced Observer Award

Charles E. Allen, Evansville Astronomical Society; **Peter K. Detterline,** Member-at-Large;

Master Observer - Silver Award

Charles E. Allen, Evansville Astronomical Society; **Rob Ratkowski,** Haleakala Amateur Astronomers;

Binocular Master Observer Award

Brad Young, Astronomy Club of Tulsa

For news of COMING LEAGUE EVENTS please see the Astronomical League website, *astroleague .org*

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

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