Reflector

Published by the Astronomical League Vol. 69, No. 1 December 2016

A Beginner's Guide to Collecting Meteorites

Asteroid Van Zandt

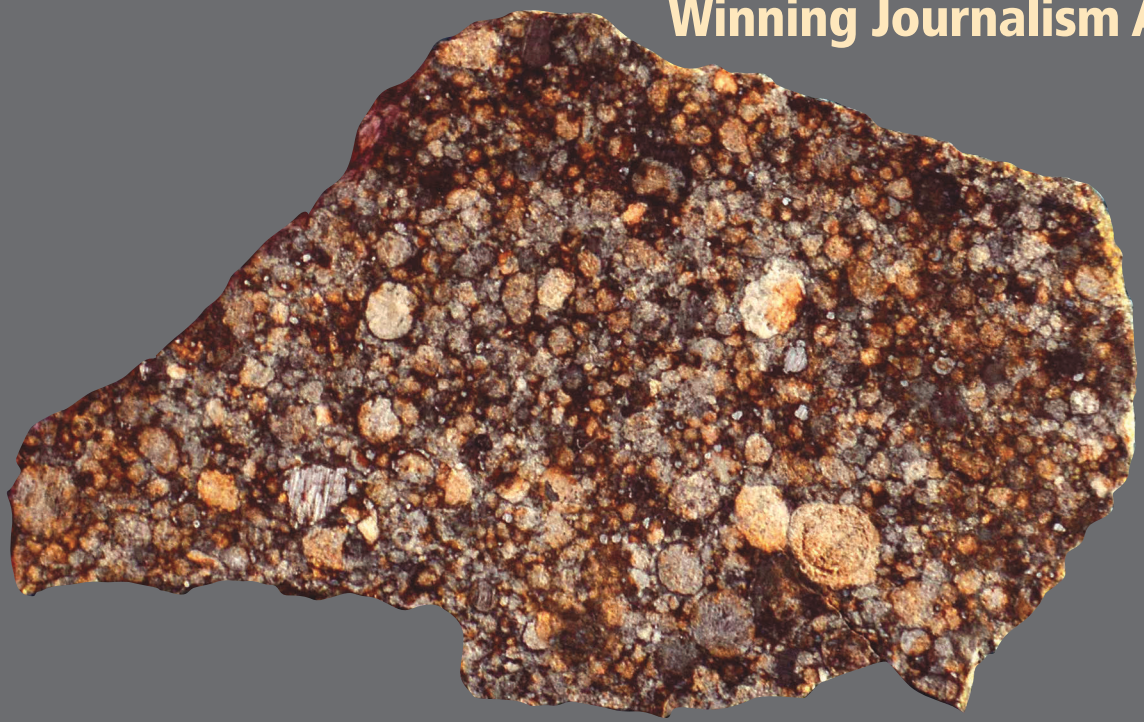
Imaging Distant Galaxy Clusters

Virginia Beach Boardwalk Astronomers

From Around the League:

League Officer Nominations

Winning Journalism Award Essays



The Astronomical League helps members explore the wonders of our universe—maximize your membship!

Observe Programs. Just about everyone has heard of the more than 50 AL Observe Programs. These are a group of nationally recognized observing lists and activities. Some are suitable for novices, some are for intermediates, while others are strictly for advanced amateurs. These clubs provide a low stress way to view the many wonders of the night sky.

League Awards. The Astronomical League wants to recognize those dedicated individuals who make astronomy happen. Every year, the League gives awards in several different areas: the Mabel Sterns Newsletter Award, the Webmaster Award, the National Young Astronomer Award, the suite of Horkheimer Youth Awards, the Astronomics Sketching Award, and others. New this year are the OPT Imaging Awards!

***Reflector* Magazine.** Every member receives this full color quarterly magazine that's published for League members by League members. Members are encouraged to submit articles and images for our national readership of over 16,000 amateur astronomers. The magazine also puts members in touch with dozens of star parties located all over the country and features columns from other professional groups.

League Store. We have a great League Sales Office, run by a dedicated and talented staff. Our astronomical handbooks are low cost and very popular — another of the many benefits of League membership. League Sales is vastly expanding its inventory, has gone to a color catalog, and now has on-line credit card capability.

Book Service. Searching for that special astronomical title in print? Separate from League Sales, the League provides a 10% discount on astronomy books with no shipping charge.

National Convention of the Astronomical League. At our National and Regional meetings, members rub shoulders with, among others, research astronomers, astronauts, authors, magazine editors, university professors, equipment manufacturers, as well as officers of the League. This is your chance to talk shop with those in-the-know.

National Voice. The AL is an active and vital member of the amateur astronomical community. The League gives amateur astronomy a national voice on important issues such as the fight against light pollution.

www.astroleague.org

TITLE PHOTOGRAPH: NGC 1850, THE DOUBLE CLUSTER. CREDIT: NASA, ESA, AND MARTINO ROMANIELLO (EUROPEAN SOUTHERN OBSERVATORY, GERMANY)

Contents

Top image: Zag (Morocco) H3-6 Chondrite, which fell in Morocco on August 4 or 5, 1996. Weighing 56 grams, this slice measures 180 x 106 x 1 mm. From the collection of Ron J. Kramer.

Bottom image: Parnallee LL3 chondrite, which fell in the Madura district, Tamil Nadu, India, on February 28, 1857. Note the exquisite preservation of the chondrules, which were formed during the condensation of the solar nebula. Speciment is a 5.5-gram partial slice measuring 42 x 26 x 3 mm. From the collection of Gregory T. Shanos.

To our contributors: The copy and photo deadline for the March 2017 issue is January 1. Please send your stories and photos to our managing editor, **Ron Kramer** (*editor@astroleague.org*), by then.

The Astronomical League invites your comments regarding this magazine. How can we improve it and make it a more valuable resource for you, our members? Please respond to the editor's email address above.

Reflector

The Astronomical League Magazine

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A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION

To promote the science of astronomy
- By fostering astronomical education,
- By providing incentives for astronomical observation and research, and
- By assisting communication among amateur astronomical societies.

Astronomical League National Office:
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Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

Issued by the Astronomical League in March, June, September, and December, the *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 the *Reflector* are available at the following subscription rates, payable to the League's national office.

Paper subscriptions:
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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**

Field of View

From the office of your president

What would amateur astronomy look like if there were no Astronomical League?

Can you imagine what the world of the amateur astronomical community would be like if the Astronomical League had never existed? The life of today's amateur astronomer would certainly be different, and, in many ways, much less rewarding.

An isolated and sparse nightscape with no Astronomical League in sight

People standing at their telescopes wonder what they should attempt to find, with no clear goals in mind. They have little direction, and they have little encouragement on developing their abilities to explore the heavens. As a result, little is what they find, and little is what they experience.

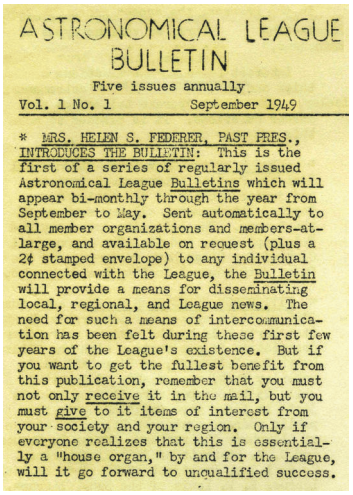
Clubs across the country have limited contact with one another, with a limited exchange of useful ideas. Their members do not readily know about the accomplishments of people outside their clubs' service areas.

Hard work by newsletter editors goes unrecognized. Webmasters remain in the background. Amateur astronomers who make lasting contributions to our hobby stay largely unknown.

Enthusiastic youths are not exposed to what others are doing across the country, diminishing their interest in amateur astronomy. Aging club members see few active young people who will eventually grow into leadership roles.

Information about public outreach events and activities is not shared between clubs. One day is not set aside each year for amateurs nationwide to show off their hobby to the public, educating people on the importance of our wonderful avocation. Astronomy conventions and gatherings do not have a national reach.

Dark pollution, an accepted term before light pollution came into popular use, is a beast which, at best, no one tackles, and, at worst, no one recognizes. The dark just might be lost without much of a struggle.



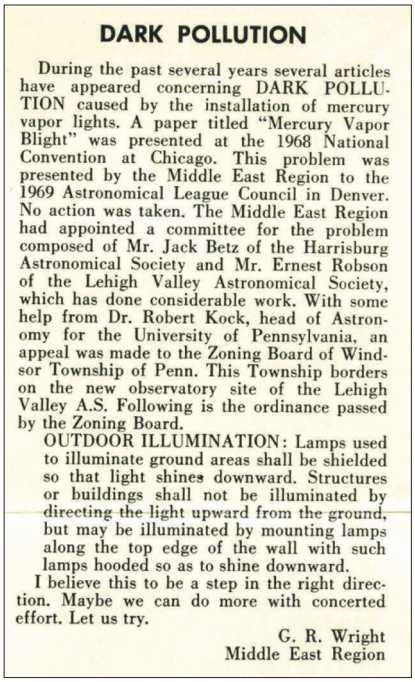
ASTRONOMICAL LEAGUE BULLETIN

Five issues annually

Vol. 1 No. 1 September 1949

* MRS. HELEN S. FEDERER, PAST PRES., INTRODUCES THE BULLETIN: This is the first of a series of regularly issued Astronomical League Bulletins which will appear bi-monthly through the year from September to May. Sent automatically to all member organizations and members-at-large, and available on request (plus a 2¢ stamped envelope) to any individual connected with the League, the Bulletin will provide a means for disseminating local, regional, and League news. The need for such a means of intercommunication has been felt during these first few years of the League's existence. But if you want to get the fullest benefit from this publication, remember that you must not only receive it in the mail, but you must give to it items of interest from your society and your region. Only if everyone realizes that this is essentially a "house organ," by and for the League, will it go forward to unqualified success.

The humble beginnings of the Reflector *in September 1949. Mabel Sterns was the editor of the two-page* Astronomical League Bulletin.



DARK POLLUTION

During the past several years several articles have appeared concerning DARK POLLUTION caused by the installation of mercury vapor lights. A paper titled "Mercury Vapor Blight" was presented at the 1968 National Convention at Chicago. This problem was presented by the Middle East Region to the 1969 Astronomical League Council in Denver. No action was taken. The Middle East Region had appointed a committee for the problem composed of Mr. Jack Betz of the Harrisburg Astronomical Society and Mr. Ernest Robson of the Lehigh Valley Astronomical Society, which has done considerable work. With some help from Dr. Robert Kock, head of Astronomy for the University of Pennsylvania, an appeal was made to the Zoning Board of Windsor Township of Penn. This Township borders on the new observatory site of the Lehigh Valley A.S. Following is the ordinance passed by the Zoning Board.

OUTDOOR ILLUMINATION: Lamps used to illuminate ground areas shall be shielded so that light shines downward. Structures or buildings shall not be illuminated by directing the light upward from the ground, but may be illuminated by mounting lamps along the top edge of the wall with such lamps hooded so as to shine downward.

I believe this to be a step in the right direction. Maybe we can do more with concerted effort. Let us try.

G. R. Wright
Middle East Region

The first occurrence of the topic of light pollution in the Reflector *was in the November 1970 issue.*

In essence, there is no genuine sense of a national amateur astronomical community working together, solving the challenges that confront today's hobby. Yes, people will still gaze at the stars, but they will come away with an incomplete experience.

The reach of a respected national amateur astronomy organization

Being under the stars, observing the night sky firsthand, and appreciating the wonder, beauty and mystery of this incredible universe are large parts of the attraction of our amazing avocation. Because of the Astronomical League, people are encouraged to spend time under the celestial dome and to find fascinating sky treasures.

Consider that in the fifty years (yes, 50!) since the first observing program—the Messier—was instituted, members have earned well over ten thousand pins or certificates (yes, over 10,000!) for observing a wide range of celestial objects. These structured programs, which now number more than 50, provide representative object lists and associated diverse activities, such as identifying lunar craters, witnessing eclipses of Jovian moons, splitting colorful double stars, estimating variable star magnitudes, drawing the naked-eye Pleiades star cluster, perceiving stellar lights wavering on the edge of visibility, mentally mapping the expansive Andromeda Galaxy, and discerning the weak glows of galaxy clusters. There is something for amateurs of any skill level.

The *Reflector* magazine, the premier publication of the Astronomical League, connects nearly 300 clubs across the country and over 16,000 amateurs. Members enjoy reading features by and for amateur astronomers, beginning in 1949 when the Astronomical League was a fledgling organization mailing the Bulletin to its membership. Now, 270 issues later and after several formatting advances, all members receive either a digital or a

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TITLE PHOTOGRAPH: BIG LICK GALAXY GROUP; LYNN HILBORN; WHISTLE STOP OBSERVATORY; GRAFTON, ONTARIO, CANADA

TITLE PHOTOGRAPH: SEYFERT'S SEXTET, NASA GODDARD SPACE FLIGHT CENTER

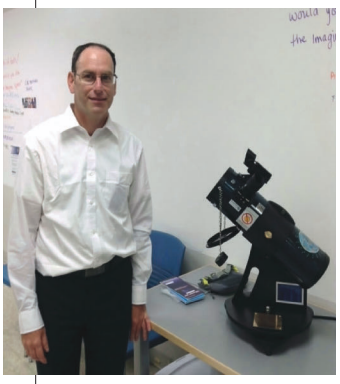
Dear Editor:

Earlier this year, I donated a telescope in memory of my parents to the Ottawa Public Library Imagine Space.

A collaboration between the Ottawa Public Library and the U.S. Embassy in Ottawa, the Imagine Space is a public makerspace—a place where customers can use high-tech tools to create and innovate.

The instrument is an Orion StarBlast 4.5-inch tabletop telescope that was modified for public use. The dust caps on the eyepiece and telescope were attached by chain so that they cannot get lost. A Celestron zoom eyepiece (8 to 24 mm) was bolted in place so that it cannot be removed. Three stickers were put on the telescope: a Sun sticker warning never to look at the Sun, an eyepiece magnification chart sticker that shows what magnification you will have for each setting of the zoom eyepiece, and a Moon map sticker oriented as you would see the Moon in the eyepiece. A sliding Moon disk on the optical tube was also added. If the Moon is too bright, you can keep the dust cover on the optical tube and just slide the Moon disk on the dust cover to the open position.

A member of RASC checks out the telescope while attendees mix and mingle.



Mark Narwa with the donated telescope at the Ottawa Public Library Imagine Space.

Included when borrowing the telescope from the library is an accessory bag that is attached to the arm of the telescope by a seat belt clamp. In it is an instruction manual, a constellation book, a red LED flashlight, a pocket planisphere, and a sky guide.

To get the telescope loan program off the ground, the Ottawa Public Library Imagine Space hosted a launch for the telescope on June 28, 2016, titled "Things Are Looking Up." The Library used social media to get the message out.

Over 30 people registered for the event. A representative of the Royal Astronomical Society of Canada (RASC) Ottawa Centre gave a presentation about astronomy. There were various astronomy handouts, activities for the kids, and yummy refreshments.

The day after the launch, the telescope was available to be borrowed for 7-day loans. A mother and son who were present at the launch showed up bright and early the next day to borrow the telescope. Since then, it has been borrowed every week.

The library plans to do some future in-house programs with the telescope.

Mark Narwa
Member-at-Large
Ottawa, Ontario, Canada

Dear Editor:

The Flint River Astronomy Club (FRAC) has been an AL affiliate ever since our first meeting in February 1997. Eighteen people attended that inaugural meeting, and five of them are still in the club. We wondered how we could honor them for their role in FRAC's founding.

At our July meeting, our program was a trip down memory lane, "FRAC's First Year," and we presented those five charter members with AL polo shirts with "FRAC Charter Member" or "FRAC Co-Founder" printed on the back. It was, we felt, a fitting tribute to them for nearly two decades of service to our club, and a celebration of FRAC's long association with the Astronomical League as well.

Bill Warren
Flint River Astronomy Club

PHOTO BY BILL WARREN

Founding and charter members of FRAC.

Dear Editor:

In the *Reflector*, June 2016, pages 18–19, the "Fathom" article (by Dave Tosteson) was astronomically superb philosophy.

Some unfamiliar words are used, aided with a quick explanation, but on page 18, mid-column 3, there is "atanaclasis," which surely must be misspelled or garbled in some way. It does not correspond to any Greek word. Perhaps the phrasing should have been "such as at anaclasis," or delete "at." Greek anaklasis is "a bending back." So I am asking you—what happened there? Something went wrong with the word. Please supply the Greek word.

Your article is a keeper.

Nowadays there are too many who want to avoid entelechy!

Carl Masthay, retired medical editor, linguist, Algonquianist
Creve Coeur (St. Louis), Missouri,
cmasthay@juno.com

Tosteson replies:

Carl, you are correct, the word should be "antanaclasis" with an "n" as the second letter. Thanks for your careful reading. This was my error.

Dear Editor:

Nice article ("John Henry Owned a Dobsonian") in the September *Reflector*. I enjoyed it!

Visual observing and imaging are nearly different hobbies. While some amateur astronomers enjoy both, most tend toward one or the other, and I doubt that either fully understand the motivation of their counterparts.

I would consider myself a "traditional" amateur, fully immersed in the world of visual astronomy. I rose through the ranks, so to speak, in the long-established way: learning the sky by eye and through a small department store telescope (which is still a treasured possession) and gradually increasing my knowledge and investment over many years. As my interest and observing skill grew, so did the aperture of my telescopes. Now, many decades after first light in that small refractor, astrophotography still has almost no appeal for me.

As you have, I have witnessed many "newbies" dive right into imaging and I've seen a lot of new astronomers rely so much on go-to that they hardly know the sky at all. I wouldn't, however, say I share "concern" over that. My credo is that amateur astronomy is a hobby, and there isn't a wrong way to do it.

I'm not very worried that visual astronomy will disappear either. It will remain a part of our hobby because it is so more easily shared. Imagers like to work alone, and even when they are in large gatherings they tend to isolate themselves. The interaction at star parties and club observing events always involves enjoying the view through the eyepiece. That camaraderie and shared experience is a big part of the hobby and insurance that visual observing will endure.

That aspect extends to outreach, too. An astrophoto will never have the visceral impact of seeing the real thing with your own eyes. I can't imagine doing outreach without actually looking through telescopes, can you?

I imagine many visual astronomers feel a sense of being left behind, of not doing "real" astronomy because they are not producing data. I've felt that myself. There is, however, something to be said for the skill and dedication it takes to push that visual envelope and see fainter and further with one's own eyes. It can yield a sense of prideful accomplishment that I doubt is duplicated by yet another image of M42. To be sure, it's not for everybody, but for those that get it, it's a sort of rush that is unique to our breed.

Ted Forte
Desert Coyote Observatory
Huachuca Astronomy Club, Sierra Vista, Arizona
Chair, Planetary Nebula Program
Master Observer #34

For those of you who are not aware of it, the Astronomical League is on Facebook. We continue to build followers week by week, and we are becoming better known as the word spreads. We are also on Twitter: @AstronomyLeague.

Happy Centennial to the National Park Service!

2016 is an election year in which the president, one-third of the Senate, and all of the House of Representatives are elected. Elections are always contentious with disagreements between persons of good will on both sides of the aisle, politically speaking.

2016 also marked the 100th anniversary of the establishment of the National Park Service (NPS) on August 25, 1916. Our national parks enjoy almost universal acclaim. The United States is a wonderful country for which we can be thankful. Although there are some areas where we, as a nation, do not do things as well as we could, we do parks and protected spaces very well. In my opinion, we need more of them, and we need to find the monies to support them better. We also need to include preserving dark skies as a prime mission of our parks and protected spaces.

The National Park Service was created by an act signed by President Woodrow Wilson on August 25, 1916. Yellowstone National Park was established by an act signed by President Ulysses S. Grant on March 1, 1872. Yellowstone was the nation's first national park and is generally designated as the world's first true national park. By August 1916, the Department of Interior managed 14 national parks, 21 national monuments, and the Hot Springs and Casa Grande Ruins. There was no unified organization to manage these parks and monuments. To rectify this situation, Congress passed the National Park Service Organic Act, which established the National Park Service and placed all existing parks under its direction. This legislation also established the fundamental mission, philosophy, and major policies of the National Park Service. A very interesting timeline and brief history of the National Park Service can be found at *www.nps.gov/parkhistory/hisnps/NPSHistory/timeline_annotated.htm.*

IDA has been active in encouraging the NPS to improve the lighting in the national parks and their surrounding communities. The NPS now recognizes the preservation and restoration of a dark sky as a prime part of its mission. The National Park Service's commitment to protecting dark skies is well documented on the NPS website, at *www.nps.gov/subjects/nightskies/index.htm.* I recommend it highly. In fact, I strongly recommend you spend as much time as possible exploring the National Park Service website, *www.nps.gov* .

IDA has recognized 13 U.S. parks as International Dark Sky Parks:

1. Natural Bridges National Monument, Utah, 2007. Natural Bridges is located in the sparsely populated southeastern part of Utah with no light pollution. It was not only the first NPS park to become a Dark Sky Park, but it was the very first Dark Sky Park.

2. Big Bend National Park, Texas, 2012.

3. Death Valley National Park, California, 2013. Death Valley has an area of 8,540 square miles and is the largest International Dark Sky Park thus far.

4. Chaco Culture National Historical Park, New Mexico, 2013.

5. Grand Canyon–Parashant National Monument, Arizona, 2014.

6. Hovenweep National Monument, Utah and Colorado, 2014.

7. Capitol Reef National Park, Utah, 2015.

8. Canyonlands National Park, Utah, 2015.

9. Black Canyon of the Gunnison National Park, Colorado, 2015.

10. Grand Canyon National Park, Arizona, 2016. The Grand Canyon is one of the most iconic parks in the world. The canyon itself is 277 river-miles long, up to 18 miles wide, and in places up to a mile deep. It is truly one of those places photographs cannot do justice. No matter how good your picture, it cannot capture the awe and thrill one feels when standing close (but not too close!) to the edge of the Grand Canyon. The Grand Canyon National Park is currently a "provisional" International Dark Sky Park as the park has up to three years to finish retrofitting its many lights to comply with the strict lighting guidelines required for a Dark Sky Park designation.

11. Capulin Volcano National Monument, New Mexico, 2016.

12. Flagstaff Area National Monuments (Sunset Crater Volcano, Walnut Canyon, and Wupatki), Arizona, 2016. These three national monuments are in the Flagstaff, Arizona, region and collectively are designated an International Dark Sky Park. The city of Flagstaff is the world's first Dark Sky Community.

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TITLE PHOTOGRAPH: "RING GALAXY," AM 0644-741; CREDIT: NASA, ESA, AND THE HUBBLE HERITAGE TEAM (AURA/STSCI)

TITLE PHOTOGRAPH: DWARF GALAXY NGC 1569; ESA, NASA, AND P. ANDERS (GÖTTINGEN UNIVERSITY GALAXY EVOLUTION GROUP, GERMANY)

Reflections

Imagine for a moment that you are on the island of Príncipe, off the west coast of Africa. The date is May 29, 1919, and you're standing next Sir Arthur Eddington, the distinguished physicist. Eddington's expedition was to observe a total solar eclipse, and to test Albert Einstein's prediction of the bending of light around the Sun (due to gravity), which was part of Einstein's general theory of relativity. This was considered by some to be one of the most important experiments in history. The background stars, during totality, were indeed slightly out of their normal positions: proof that the Sun's gravity had actually bent the light from the stars! A major milestone in physics and astronomy.

Now, think of the excitement if you could repeat this exact same experiment for yourself. Well, guess what—you can!

On August 21, 2017, there will be another total solar eclipse, visible across a large portion of the United States. The Astronomical League has developed the Solar Eclipse Special Observing Award, which essentially duplicates (and reconfirms) Eddington's results. Further information is available at *www.astroleague.org*. I am certain there will be several attendees at AstroCon2017 in Casper, Wyoming, who will work on this important program. This award can be won by any observer at totality.

The League has also just started an Imaging Program. The details are being ironed out and will be available at the League's website, given above.

As I write this, I think about the wonderful time had by all at ALCon2016, in Arlington, Virginia. There were a bunch of great speakers, excellent Star-B-Que, and awards banquet. As usual, many awards were given and a few Master Observers were also recognized. Congratulations to NOVAC (Northern Virginia Astronomy Club) for a job well done.

During the general meeting on Saturday, August 13, League election results were detailed. Present officers John Goss (president) and William Bogardus (vice president) were reelected to two-year terms, and somehow I was elected executive secretary (three-year term), stepping in for (but never replacing) Ron Whitehead, who had completed his second three-year term and was ineligible to run again. It seems one of the qualifications for this position is to have the name "Ron," so all you Rons out there should get ready for the next elections.

And, for some strange reason, the executive council still wants me to be involved in the production of the *Reflector*, so at the council meeting it was agreed that I would be appointed "managing editor." So, now, here I am looking for an editor. The suitable candidate will have some editing and publishing experience and the ability to collect the bits and pieces that make the magazine and put everything together. The actual formatting and layout are handled by Chuck Beucher, but the editor will coordinate the editing process (with two assistant editors), review and choose the photographs for the covers and "Gallery" section (with a photo editor), build the Observing Awards page from several dozen coordinators, and make certain everything goes to Chuck in time for production. This volunteer position takes about 10–20 hours per week for 4–6 weeks per issue, and will report to the managing editor.

We also need a replacement photo editor, as Rob Westbrook (formerly in that position) is unable to continue, due to time constraints.

If anyone out there is interested in either the editor or photo editor position, please let me know as soon as possible at *ronjkramer@aol.com*. I would like to start the training process in time for the March 2017 issue.

Also during the general meeting, it was reported that the membership voted to change the bylaws, allowing an International Region to be formed. Details will follow during the coming months.

Finally, there still seems to be some confusion about the addition of digital copies for subscribers to the *Reflector*. Perhaps this will help clarify the situation:

- Subscribers have the option to receive a paper copy, a digital copy, or both.
- All subscribers will receive the digital copy unless they "opt out" (inform us they do not want the digital version).
- All subscribers will also receive the paper copy unless they "opt out" (inform us they do not want the paper version).

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Wanderers in the Neighborhood

The Storms of Jupiter

On July 5, 2016, the giant planet **Jupiter** acquired yet another, though very small, moon. NASA's **Juno** spacecraft swung around Jupiter, firing its rocket motor to slow it down into Jupiter's gravitational embrace. This spacecraft will pick up where the Galileo spacecraft left off after it was purposely sent into Jupiter's atmosphere on September 21, 2003.

We have learned much about Jupiter's atmosphere from hundreds of years of observation. Jupiter's clouds are mainly ammonia, and possibly ammonium hydrosulfide, with some trace elements thrown in. Ultraviolet light striking the molecules causes them to change color, giving us the amazing palette of colors that spread over this planet's disk.

The clouds in Jupiter's darker belts are cooler material descending toward the warmer lower levels. The internal downdrafts in the belts make them low-pressure regions where the clouds are at a lower altitude. Material in the neighboring lighter zones is warmer and ascending. The upward flow creates a high-pressure region where the clouds are at a higher altitude. Material from the upwelling zones begins to cool as it rises and spills over into the belts. The Coriolis effect turns this spillover flow from north–south to east–west, forming high-speed jet streams. The speed of these winds is probably due to the fast rotation of Jupiter, completing one sidereal rotation in only 9 hours, 55 minutes, and 30 seconds.

These jet streams travel at speeds over four hundred miles per hour in a straight east or west direction between the belts and the zones. Eastbound jets form the transition from zones to belts (going away from the equator) while westbound jets mark the transition from belts to zones. Material from the zones flows into these jets and is carried along as it works its way across to the belts. As the cooling material leaves the jet, it enters the belt where it drops toward the warmer, lower layers.

The boundary between the belts and the zones is an area of instability where vortices can easily form. A vortex appears to us as a spot between a belt and a zone, with the most famous and long lasting of these being the **Great Red Spot**. The first observation of the Great Red Spot was most likely made by Italian-French astronomer Giovanni Cassini in 1655 and not reported until 1713. However, this spot's motion does not seem to match that of the present-day Great Red Spot. Also, there were no reports of a spot between 1713 and 1829, so it may well be that Cassini's spot is not the one we see today. Ours was definitely seen in 1830 and has been regularly observed since then. It is unknown whether Cassini's red spot disappeared and reformed or just went unrecorded for more than a century.

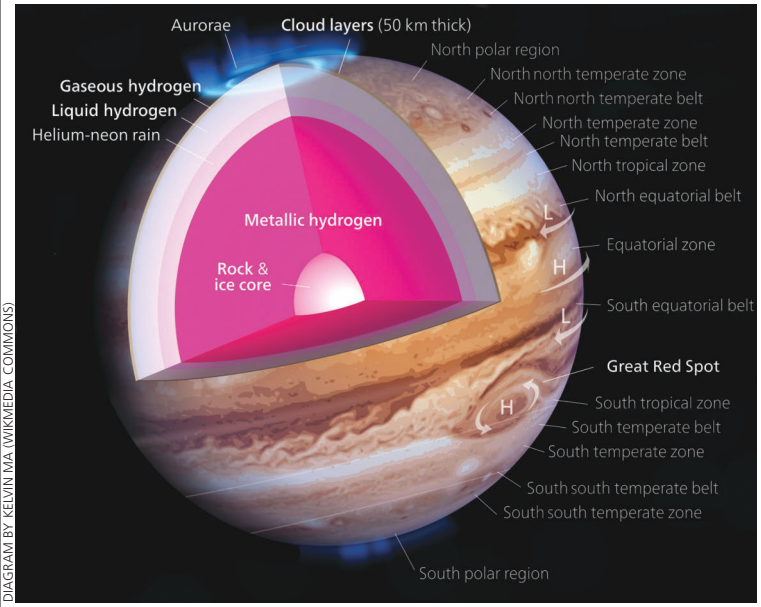

DIAGRAM BY KELVIN MA (WIKIMEDIA COMMONS)

Jupiter is composed mostly of hydrogen in a metallic (conductive) state over a core of ice and rock. Above it, the metallic hydrogen blends into liquid hydrogen and then gaseous hydrogen. The rapid rotation of Jupiter transfers energy to the atmosphere by the Coriolis effect, which causes high-pressure systems like the Great Red Spot in the southern hemisphere to rotate counterclockwise. The same storm would rotate clockwise if it were in the northern hemisphere.

Our Great Red Spot is a storm in the southern hemisphere of

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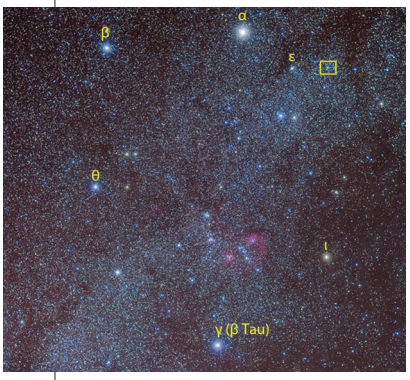
DEEP-SKY OBJECTS

THE MANTA RAY CLUSTER

By Dr. James R. Dire, Kauai Educational Association for Science & Astronomy

Auriga is one of the most splendid constellations in our winter sky. From Earth, the constellation is located in the opposite direction of the galactic center. So the winter Milky Way passes right through Auriga, filling the constellation with scores of star clusters and nebulae. I identify Auriga by five bright stars, Alpha (Capella), Beta (Menkalinan), Theta, Gamma (Elnath), and Iota (Hassaleh) Aurigae, which form a large pentagon in the sky. Elnath is also known as Beta Tauri. The star was considered to be part of both Auriga and Taurus until 1930,



when the International Astronomical Union established the modern constellation boundaries and dropped Elnath from Auriga. But I digress. The Milky Way runs from northwest to southeast across the constellation. Auriga contains three Messier objects and myriad NGC-designated star clusters and nebulae.

One of the lesser-known, but extremely pretty, star clusters in Auriga is NGC 1664. NGC 1664 resides on the border of Auriga and Perseus, lies five degrees southwest of Capella, and two degrees due west of the third-magnitude star Al Anz (Epsilon Aurigae). The accompanying wide-field, long-exposure image of Auriga has Auriga's brightest stars labeled with their Greek letter designations. I have also labeled Al Anz (ε). In the image, north is up and west to the right. The yellow box shows the location of NGC 1664 and approximates the field of view of the telescopic image of the cluster, also on this page.

The brighter band of the

Milky Way paves a path across a diagonal of the wide-field image. Notice the dark cloud on the upper right-hand corner of the image with two lanes coming out of it. One dark lane extends down to just north of Al Anz, while the other lane runs straight south, passing west of NGC 1664, cutting across the entire bright Milky Way lane. The lanes can be seen from a very dark site with excellent transparency using large binoculars or a small telescope. NGC 1664 lies on the edge of the brighter portion of the Milky Way, between these dark lanes.

NGC 1664 is a loose open star cluster containing approximately 50 stars. Eighteen of the stars are around 10th and 11th magnitude; the rest are fainter. Overall, NGC 1664 is magnitude 7.6 and spans 9 arcminutes of sky. The cluster lies 3900 light-years away.

The center of the cluster contains many white and yellow stars, with several red stars scattered about. The colors should be readily apparent in 6- to 8-inch telescopes. On the southeast side of the cluster lies a magnitude 7.5 blue-white star (HD 30650) that is not a member of the cluster, but looks striking in the same field of view.

To me, the brighter stars in the center of the cluster trace out the shape of the body of a manta ray. The ray appears pointed northwest. The tail of the manta ray is formed by a chains of stars starting on the southeast side of the ray's body and curving to the south, ending just to the west of HD 30650.

My image of NGC 1664 was obtained on the night of February 2, 2014, using a 10-inch f/4.6 Newtonian astrograph with Tele Vue Paracorr II coma corrector, an SBIG ST-2000XCM CCD camera, and a 30-minute exposure.

Near the bottom of this image, just to the right of center, is a fine optical double star consisting of a 9th-magnitude white star and an 11th-magnitude red star forming a north-south line. In 14-inch or larger telescopes, there is a 14th-magnitude star visible just to the west of this pair. This fine doublet, like HD 30650, is not physically part of NGC 1664, but just lies along the cluster's line of sight.

Take time to enjoy all of the details of NGC 1664 and its surroundings on this detour from the better known star clusters in the constellation Auriga.

Gallery

Kevin Witman, a member of the Astronomy Enthusiasts of Lancaster County (Pennsylvania) and part-time planetarium operator and presenter, submitted this view of M8, the Lagoon Nebula. It consists of a stack of twenty-five 180-second light frames calibrated with twenty-five 180-second darks, flats, and bias frames. Equipment was a Stellarvue 102ED refractor, iOptron iEQ45 computerized mount, and an Orion StarShoot autoguider package using PHD. The camera was a modified Canon XS DSLR at ISO 800, and the image was processed using ImagesPlus (version 3.82) and Photoshop 5.

An SBIG STT-8300M camera with LRGB filters, Astrotech AT106 triplet refractor, and Losmandy G11 mount were used for this image of Antares and globular cluster NGC 6144, taken by Aubrey Brickhouse of the Central Texas Astronomical Society, from a viewing field at the Meyer Observatory, just outside Clifton, Texas.

TITLE PHOTO: NGC 2244; BRIAN KIMBALL

Mayhill, New Mexico, has some of the darkest skies in the continental United States, as evidenced by this submission from David Doctor of the Astronomical Society of Las Cruces. This image shows the Sagittarius region of the Milky Way, and was captured using a Canon 60D, 10 mm lens, Polarie Star Tracker, and a series of twenty-four 3-minute exposures, processed in PixInsight.

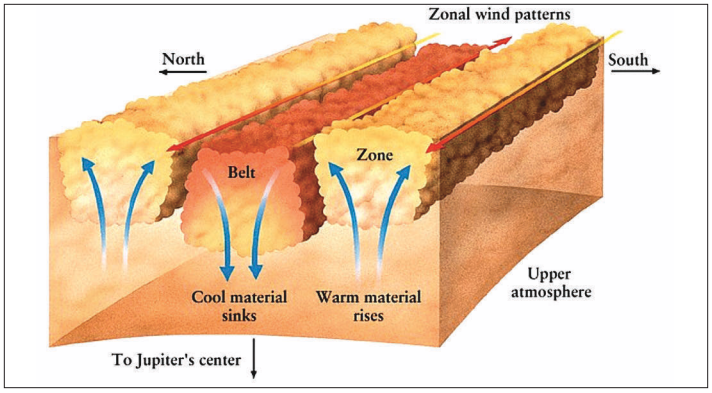
IC 1396 and the Elephant Trunk Nebula was imaged by Brad Miller of the Bucks-Mont Astronomical Association (Pennsylvania), on August 27, 2016, from Cherry Springs State Park. He used a Celestron C8 with HyperStar at f/2.1 on an AVX unguided mount with a Sony NEX-F3 and 30 x 30-second exposures at ISO 12,800, stacked in RegiStax and processed in Photoshop.

Wanderers in the Neighborhood/*from page 8*

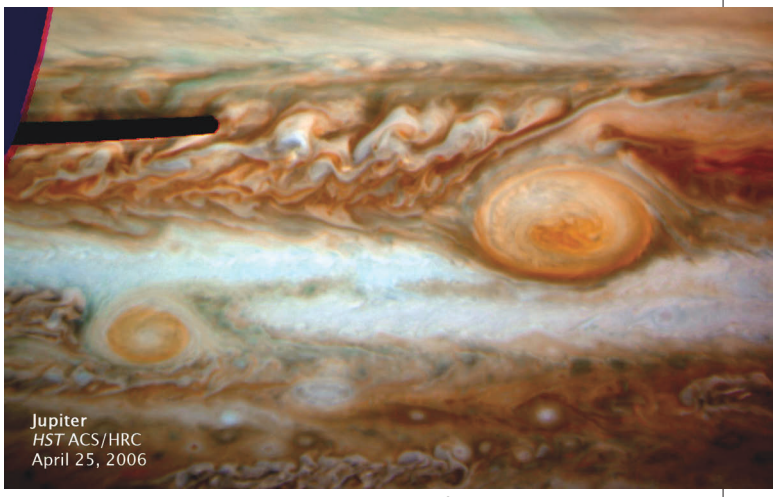
Jupiter, mostly in the South Equatorial Belt but also on the edge of the South Tropical Zone. The spot is an oval with a north–south extent a little larger than the diameter of the Earth, rotating in about six of our days. We do not know whether the Great Red Spot transfers kinetic energy to the adjacent zone and belt, or the adjacent zone and belt transfer energy to the Great Red Spot.

The Great Red Spot is sometimes referred to as a hurricane, but this is inaccurate: the material in the Great Red Spot is welling up from the warm interior, making this a *high-pressure* area (an anticyclone, with counterclockwise rotation) whose clouds are five miles above the surrounding clouds. While the Great Red Spot's cloud tops are colder than their surroundings due to their higher altitude, the maximum temperatures five hundred miles above the clouds above the Great Red Spot are much higher than elsewhere on Jupiter. This demonstrates that heat from the planet's interior is being transported to the upper atmosphere through the Great Red Spot and probably other anticyclones.

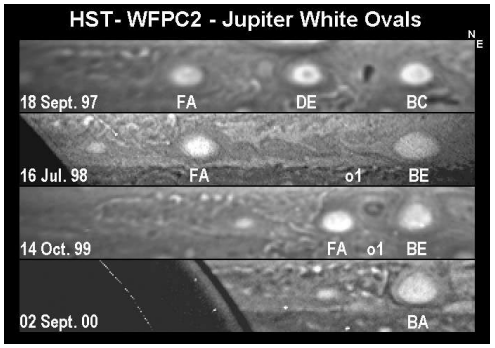
The Great Red Spot was much redder in the middle of the last century. The color may come from red phosphorus or another sulfur-containing complex organic compound. The color could also come from the abundant ammonia and trace acetylene gases being lofted high enough to be broken apart by the Sun's ultraviolet light, producing reddish compounds that might give the Great Red Spot its color. Since the middle of the last century, the Great Red Spot has been becoming a lighter red and this oval has been slowly shrinking in longitude, becoming more circular. It is possible that one day our Great Red Spot may be gone completely.



This is a cross-sectional view of the belts and zones, showing bubbles of warm material rising in the zones. In the neighboring belts, cooler material is drifting downward toward the warmer, lower areas. Jet streams flow in opposite directions at the boundaries of the belts and zones. These jet streams result from the wind flow from the zones to the belts being turned by the Coriolis effect. (From Universe*, by Freedman, Geller, and Kauffman, © 2014)*



Jupiter's Great Red Spot and Red Spot, Jr., in a family portrait with images taken in April 2006. The images were taken with the Hubble Space Telescope's Advanced Camera for Surveys. The two spots have since passed each other on a regular basis without interacting. (NASA; ESA; A. Simon-Miller, NASA/GSFC; and I. de Pater, University of California, Berkeley)



These four images were taken over three years showing the white Ovals FA, DE, and BC as they merged to form Oval BA. The white Oval BA changed its color to red, becoming Red Spot, Jr. The three ovals had coexisted for sixty years before they finally merged into one. White ovals move at different speeds and eventually meet and merge to form larger ovals. These images were taken with the Hubble Space Telescope's Wide Field and Planetary Camera 2. (NASA/JPL/WFPC2)

The long life of the Great Red Spot might be attributed to some feature below the cloud surface. However, the Great Red Spot moves independently from the rest of the planet so it is not attached to anything below the clouds. The Great Red Spot has moved around the planet at least ten times since the 19th century, showing that it is an atmospheric phenomenon.

There are other vortices on Jupiter. Many appear as white ovals that also move around the planet independently. They are almost all anticyclonic storms that are much smaller than the Great Red Spot, with correspondingly lower clouds. Perhaps the clouds in the white spots do not get high enough for the Sun's ultraviolet light to break the component molecules into reddish compounds. White ovals or spots form and disappear on short timescales, sometimes lasting for many years or just a few months. The Cassini spacecraft imaged white spots being torn apart as they passed around the Great Red Spot, but white ovals have also merged together.

In 1939, the South Temperate Zone was torn apart by dark features into three long white sections that were dubbed AB, CD, and EF. As the dark features expanded, these sections were compressed into white ovals, which were named FA, BC, and DE. Over the next sixty years, the three ovals moved independently through the dark features. In 1998, Ovals BC and DE merged to become Oval BE. In March 2000, BE and FA merged to form a larger white Oval BA. Oval BA began to turn red and by August 2005, Filipino amateur astronomer Christopher Go reported that this oval had become the same color as the Great Red Spot. Oval BA has since been dubbed **Red Spot, Jr.**

Jupiter is a dynamic place with continuous changes that are fascinating and unpredictable. Jupiter's storms are just a small part of the story of Jupiter's atmosphere. Even after many observations, images, and spacecraft visits, we still have much to learn about the largest planet in our Solar System.

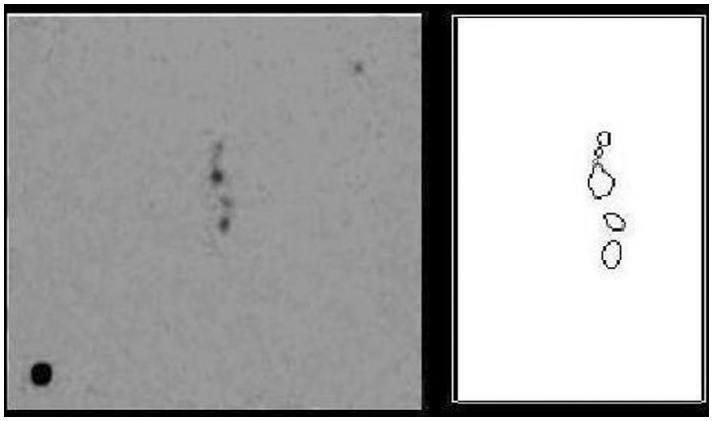
The Challenge of Imaging Three Distant Galaxy Clusters

By Frank J. Melillo, Astronomical Society of Long Island, Holtsville, New York

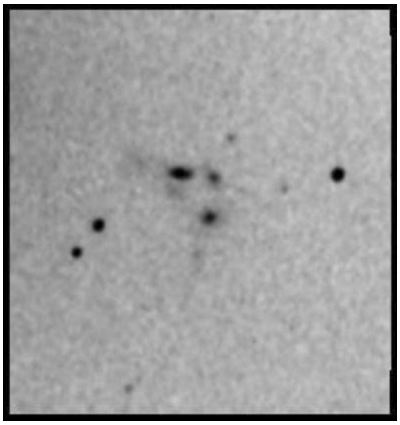
When it comes to images of galaxies, most of them are quite faint. I always look for something different and more challenging. Yes, there are plenty of spiral, elliptical, and even edge-on galaxies in all four seasons of the year. But there is a special collection of galaxies that is often overlooked, and I want to discuss those here.

Galaxy clusters, where at least four or five galaxies are located together in space, tend to be overlooked. The galaxies in a cluster are physically associated with one another. They are often referred to as an interacting group, as there is a possibility of them colliding. Almost all of them gravitationally affect one another. It is assumed that to have a system like that, they have the same redshift—meaning all of them are about the same distance from us. But astronomers made some interesting observations that there could be something wrong with this approach. To measure the distance of the group by looking at the spectra, one galaxy indicates a different distance than the rest. How could that be? By chance, could it be that one galaxy is in the same line of sight as the true group?

There are quite a few groups that show one galaxy with a different redshift. Three classic examples are VV172, Seyfert's Sextet, and Stephan's Quintet. These galaxy groups garnered the most attention when their distances were measured. Many astronomers determined that one galaxy in each group has a different redshift, yet they appeared at first glance to be connected.



Of the 5 galaxies in VV172, the third from the top is the brightest at magnitude 15.9; the second from the top is the faintest at 18.0. This second from the top has a higher redshift than the other four; the others have the same redshift. Therefore, the second from the top must in the background. To the right is a contour map of each galaxy, resampled at 1.5x.



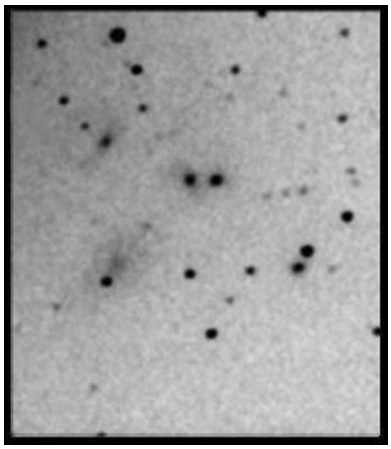
Seyfert's Sextet is a group of six galaxies that are roughly 16th magnitude each. A small galaxy below the brightest one has a higher redshift than the others, so it is actually a background galaxy.

I had an opportunity to image all three of these galaxy groups. From a moderately light-polluted sky, I never thought I would be able to capture them with my moderate-sized equipment (a 10-inch Meade LX200). These groups are so remote that they are rarely mentioned in amateur literature. Also, the members are so close together that higher magnification or a telescope with longer focal length is needed.

The VV172 group is located far in the northern sky at a declination of +70 degrees in Ursa Major. The sky in that region has so few stars that few people pay attention to it. One Russian astronomer, Vorontsov-Velyaminov (VV for short), discovered this group in 1959. It was the 172nd object in his catalogue. It is a chain with five galaxies in a line running north–south. I've stacked 8 images, each a 30-second exposure with a Starlight Xpress MX-5 camera. All five galaxies are visible. A contour map helps to see each individual galaxy easily. The second from the top is the faintest one at nearly 18th magnitude! Also, this galaxy has a much higher redshift than the other four. It seems to fit perfectly with the rest of the group in a straight row! Does this mean it is a background galaxy? Astronomers confirm it apparently is.

Seyfert's Sextet (also known as NGC 6027) is also a very interesting group. The galaxy cluster was discovered by Carl Seyfert in 1954 and is located in the constellation Serpens. With 7 exposures of 30 seconds each, all galaxies are visible. Note that the brightest galaxy appears to have a tidal plume on the left side and is not an individual object. The faintest one below the brightest galaxy has a much higher redshift than the rest. While it seems to belong to the group, it is actually in the background and is not physically associated with the other members!

One final group of galaxies is Stephan's Quintet, which consists of five galaxies, including NGC 7317–7320. The group is located in the constellation Pegasus about three-quarters of a degree away from the famous galaxy NGC 7331. This group was discovered in 1877 by M. E. Stephan. In 1961, it was recognized that one galaxy had a different redshift than the other four. I have combined 8 images with 30-second exposures and all five galaxies are visible. The lower left center galaxy has a much lower redshift than the other four. Therefore, it must be a foreground galaxy!



The galaxies in Stephan's Quintet are each about magnitude 14. Four of them have nearly the same redshift, while the brightest (lower left corner) has a much lower redshift. It is in the foreground.

It is hard to believe that all three clusters of galaxies can be imaged to duplicate on a smaller scale of what professional astronomers can do at major observatories. These three classic groupings were determined to have one galaxy in each group that has a different redshift than the rest.

ALL OPTICAL IMAGERY BY AUTHOR, USING A 10-INCH MEADE & STARLIGHT XPRESS CAMERA.

TITLE PHOTOGRAPH: M31;COMPLIMENTS OF TOM S. MARTINEZ, ASKC

Tokyo, October 6, 2016

Scientists at Tokyo Institute of Technology have demonstrated that the relatively high levels of precious metals (gold and platinum, for example) in the Earth's mantle likely originated from only one large planetary impact before the formation of the Earth's crust. This implies that the early Earth was a more benign place than previously thought, with fewer impacts from space. The findings are published in *Earth and Planetary Science Letters*, October 4, 2016.

The debate surrounding the formation of the planets in our solar system, particularly the terrestrial ("rocky") planets, has been going on for many years. Scientists have long used computer models coupled with analysis of ancient meteorites to piece together the most likely scenarios that led to forming the planets as we know them today. A few puzzles still remain, including why Mars is much smaller than most models predict, and why the Earth in particular has a large amount of iron-loving—siderophile—material in its mantle. Metals like gold, platinum, and palladium would ordinarily be sequestered in the metallic core. The existing explanation for the latter is that the Earth was pummeled by impacts in its early life, leaving the highly siderophile elements (HSE) beneath the crust.

Now, Ramon Brasser and Shigeru Ida at the Earth-Life Science Institute at Tokyo Institute of Technology, Japan, together with an international team of researchers from the University of Colorado (USA), the University of Dundee (UK), and the University of Oslo (Norway), have shown that the Earth's HSE budget was most likely the result of a single, large impact from space rather than the slow accumulation of material from many smaller impacts. This single impact may or may not have been the same one that created the Moon.

Brasser's team simulated the evolution of the terrestrial planets up to 300 million years after their first formation, much longer than in previous studies. They collated information regarding the precious metal budgets of Earth, Moon and Mars and data on lunar cratering, and ran simulations to determine the circumstances that would fit the observations.

Their results show that the total mass of planetesimals—accumulations of planet-forming material floating in space—at the time of the event that formed the Moon was less than previously thought. Mars accumulated 0.06 percent of its total mass in impacts during the period of the postulated late veneer on Earth. The single, large impact that created Earth's HSE complement was unique to Earth, and must have occurred before the crust had begun to form around 4.45 billion years ago. Brasser and his team have shown that the early Earth at the time of life's emergence was not under a constant, intense bombardment from impactors as previously thought.

The early Solar System

There is still much debate around the early formation and behavior of the planets that orbit our Sun. While the initial formation processes for the terrestrial planets—accumulation of material into planetesimals followed by the gradual growth into full-size planets—is well-researched, it has proven difficult to solve some of the more complex enigmas about the inner Solar System.

Recently, the grand tack hypothesis was proposed, in which Jupiter shifted its path inwards towards the sun before migrating back to its current position. This movement, together with the formation of Saturn and its associated resonance with Jupiter, meant that the two gas giant planets pulled an immense amount of debris and material away from the inner Solar System when they shifted back outwards. This accounts for the smaller size of Mars and for the current composition of the asteroid belt.

Questions regarding the unexplained high levels of HSE in the Earth's mantle, and indeed beneath the crust of Mars, still remain.

Implications of the current study

By combining data from various sources and simulating the early evolution of the terrestrial planets using computer models incorporating the grand tack hypothesis, Brasser and his team have provided new insights into the HSE conundrum. Their simulations suggest that the Earth's mantle composition was altered primarily by one large-scale impact—possibly the same impact that created the Moon—rather than by many small impacts. Their results also show that there was far less debris and material floating in the inner Solar System by the time the Moon-forming event occurred than scientists had anticipated. This implies that the early Earth may have been a more benign place than previously thought.

Recurrent nova research

The nova M31N 2008-12a has been observed in eruption eight times during the last eight years (2008–2015). This is by far the fastest recurrence period known for any recurrent nova in any galaxy. The latest comprehensive paper on the 2015 eruption can be found at *arxiv.org/abs/1607.08082*.

Moreover, there is good evidence that M31N 2008-12a has an even shorter recurrence period of only six months; see *adsabs.harvard.edu/abs/2015A%26A...582L...8H*.

A global network of observers using small ground-based telescopes is already monitoring the field with high cadence. Once an outburst is detected, ten-meter-class optical telescopes (W. M. Keck Observatory, Gemini Observatory, and Gran Telescopio Canarias) will perform deep follow-up spectroscopy, and space-based telescopes like Swift or XMM-Newton will provide high-energy coverage.

In addition, a campaign is planned for spring 2017, hoping to confirm the predicted 6-month period before M31 gets too close to the Sun to observe in early April.

Researchers are currently searching archives for earlier eruptions that might have been missed. Any archival observations that you might have of the northern disk of M31 with limiting magnitude of at least 18 would be of great interest. The nova is about 0.8 degree away from the M31 center, in the northern disk (at RA 00h 45m 28.81s, declination +41° 54′ 09.9″, J2000). Not all observations centered on M31 will cover this position. Please send any archival data to: *managingeditor@astroleague.org*.

Asteroid Van Zandt

By Bob Gent, Past President, Astronomical League

Photos courtesy of the Peoria Journal Star

On November 30, 2015, the International Astronomical Union renamed a minor planet **71539 VanZandt. Rollin P. Van Zandt** was the 19th president of the Astronomical League, serving from 1975 to 1977.

"Van," as he was known, was the Peoria Astronomical Society's co-founder and original driving force. As an assistant director of research at **Caterpillar Incorporated**, he convinced former Caterpillar vice president Murray Baker to support the construction of Northmoor Observatory.

Van Zandt passed away in Bisbee, Arizona, in 1994, at the age of 83, and, unfortunately, I never had the chance to meet him. As I began to research this article, a picture emerged of a wonderful person and an inspiring astronomer.

Jean Van Zandt Braxton wrote, "This photo was taken in Peoria about 1952. The children on the ground with their back to the camera are my brother and me. My sister, Judy, is just left of dad. Dad came home from work, assembled the telescope, and demonstrated it to us and our friends."

Astronomical League past president **Jim Fox** knew Van quite well, and he wrote, "perhaps Van's most stunning accomplishment was convincing me to run for AL president when Ken Wilcox bowed out for medical reasons. He was also the driving force behind the expansion of observing programs beyond the Messier program."

Jim also wrote, "I feel privileged to have considered him my friend. In my opinion, having a minor planet to honor him is long overdue."

Rollin P. Van Zandt, 19th president of the Astronomical League, assembling a telescope at home in Peoria, Illinois, in 1952

When I began looking for information about Van Zandt, I learned he had received some very impressive awards. Among many other achievements, he earned the **G. R. Wright Service Award** in 1993, the Astronomical League Award in 1988, and the North Central Regional Award in 1994. In addition to being a past president of the Astronomical League, he also served as secretary and in many other League positions.

When I first wrote to his daughter Jean and her husband, Lowell Braxton, she said, "all of us in the family are so surprised and honored to hear this most welcome news about our dad, grandfather, and uncle. He so loved astronomy and loved finding interested people with whom to share his fascination. Many, many thanks for the exciting news and this beautiful tribute to a dedicated and loving man."

Asteroid VanZandt was the idea of Richard (Rik) Hill, who recently retired from searching for near-Earth asteroids with the **Catalina Sky Survey** at the **University of Arizona's Lunar and Planetary Laboratory**.

Rik wrote, "I knew Van since the mid-1970s. and admired his patience in helping other amateur astronomers, including myself. Few people in the Astronomical League made such a lasting impression on me as Van, and that is why I took the effort to have a minor planet named in his honor."

Van Zandt's passion for astronomy was amazing. In his spare time, he taught introductory astronomy to Peoria Astronomical Society members and to undergraduates at Bradley University in Peoria, which culminated in a textbook he wrote, called *Astronomy for the Amateur*, published in two volumes. He sold 5,000 copies to amateurs and as a textbook for several universities.

Van Zandt's last project was an unpublished book, titled *A Quest for the Unknown*, dated 1987. His daughter Jean shared the preface with me, and it was stunning. He pondered the magnificence of an unbounded universe, and gave thanks to God for sharing in this wonder. His words reminded me of two quotes: the first is from the Bible: "The Heavens declare the glory of God." The other quote is from Shakespeare, when Hamlet states, "There are more things in heaven and Earth, Horatio, than are dreamt of in your philosophy."

These quotes and Rollin Van Zandt's last project touch on the nature of infinity and the relationship between science and religion. He closed his preface with the words, "And so, on with the pages to follow and the theme that science and religion are really one."

Rollin P. Van Zandt (far left) at the 1962 groundbreaking of a new planetarium in Peoria, Illinois

Boardwalk Astronomers

By Leigh Anne Lagoe, Back Bay Amateur Astronomers

Unsuspecting tourists meander down the Virginia Beach boardwalk on a Tuesday evening and find a row of telescopes along the oceanfront. A family on a bicycle built for six slows down to catch a glimpse of what's going on. About a dozen astronomers stand with their backs to the pristine view of the Atlantic Ocean, luring in people to look through their telescopes.

Early in the evening at Boardwalk Astronomy, tourists can safely view the Sun as it sets, nestled between the towering hotels, or view the Moon against the blue backdrop of the sky. Barefoot beachgoers, clutching flip-flops in their hands, come up from the sand to see what's happening. Cyclists park their bikes and peek through the eyepieces.

"Wow," is a popular response, as the light of day drifts away, revealing more prominent craters on the Moon.

The sky darkens and someone calls out that they've spotted Saturn. The faces of a twenty-something couple on their honeymoon light up as they ask, "Seriously, we're going to see Saturn?"

Tourists continue to wander by, in a steady stream throughout the night, slowing down with curious expressions as they pass the telescopes. This free public event attracts hundreds of passersby, but the lines at the telescopes are rarely long. Generally, people are content to wait patiently while enjoying the warm salty breeze off the ocean.

Boardwalk Astronomy is a joint effort of the City of Virginia Beach, the Virginia Beach Public Schools Planetarium, and the Back Bay Amateur Astronomers. The program was suggested by the planetarium director, Chuck Dibbs, after a very successful city star party. After a bit of planning with the city, the first Boardwalk Astronomy was held in 2008. It has even been arranged with the city for an entire block of boardwalk lights to be shut off during this event.

PHOTO BY LEIGH ANNE LAGOE

Also, the city's budget for entertaining tourists allows them to pay a small fee for the astronomers' service. That money is split between the astronomy club and the planetarium, and goes directly into their scholarship programs.

Feedback from the tourists has been overwhelmingly positive, and the city of Virginia Beach continues to welcome the astronomers back each year. Once a month, from about May to September, the astronomers bring their telescopes to the oceanfront at 24th Street to impress tourists from all over the world.

What a wonderful surprise for a family on vacation. Amidst the beach, tourist shops, boardwalk concerts, ice-cream stands, and boogie boards, there is something completely different that stands out and amazes them. For many visitors to Virginia Beach, stumbling upon Boardwalk Astronomy becomes the highlight of their vacation.

Whether it's mountains, lakefront, farmland, cobblestone roads, city rooftops, a fishing pier, or a boardwalk, I would encourage all astronomy clubs to find something unique about their town, and find a way to bring astronomy to it.

PHOTO BY SHAWN LOESCHER

PHOTO BY VINCE PENDLETON

PHOTO BY VINCE PENDLETON

A BEGINNER'S GUIDE TO

By Gregory T. Shanos

Amateur astronomers enjoy observing objects in the universe from afar, holding nightly vigils at the telescope, collecting ethereal photons with our eyes or with CCD cameras. Unbeknownst to many, there is also a way to collect "rock solid" representatives of the Solar System, in the form of meteorites. Starting a meteorite collection is a rewarding and educational pursuit. The following essay is a compilation of over 30 years of experience that I have gained in the art of collecting meteorites.

There are three basic types of meteorites: stones, irons and stony-irons (Figure 1). Stone meteorites comprise 92 percent of all known meteorites. Stones represent the crustal surface of an asteroid and are divided into two broad categories: chondrites and achondrites. Chondrites contain chondrules, which are small spherical bodies formed by the re-melting of mineral grains in the solar nebula. Chondrites are subdivided into ordinary chondrites and enstatite chondrites, and can be further subdivided into three basic types: H (high-iron), L (low-iron), and LL (low-low-iron). This letter designation is followed by a number, usually from 3 to 6. A meteorite with well-defined, unaltered chondrules is a 3; one with heat-altered, barely visible chondrules is a 6. For example, an H3 chondrite is high-iron with well-preserved chondrules, and an LL6 is a low-low-iron chondrite with thermally altered chondrules. The ordinary H, L, and LL chondrites are also sometimes called olivine-bronzite chondrites, olivine-hypersthene chondrites, and amphoterites, respectively.

Achondrites appear to have been chondritic before being altered by heat or impact. The HED (howardite, eucrite, and diogenite) achondrites are confirmed to have originated from the asteroid (4) Vesta (Figure 2). Other classes of achondrites include acupulcoites, angrites, aubrites, brachinites, lodranites, ureilites, and winonaites. These other classes are very rare and best collected after some experience in the study of meteorites.

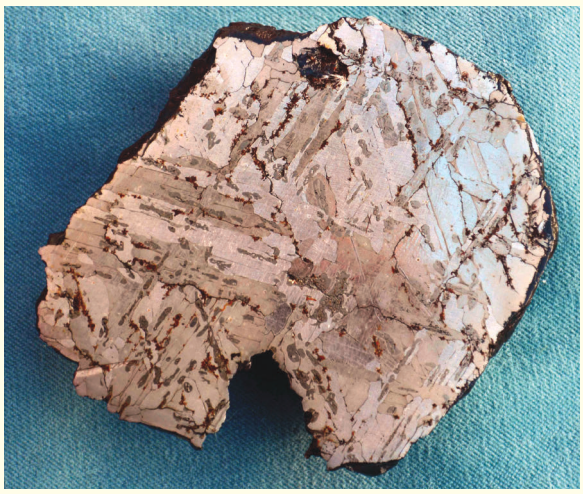
Iron meteorites comprise 6 percent of the meteorites in museum collections. Irons are pieces of the metallic core of an asteroid. Iron meteorites are divided into three broad categories based on their nickel content: octahedrites, hexahedrites and ataxites. Hexahedrites contain the least nickel, 4.5 to 5.8 percent; octahedrites contain 4.5 to 6.5 percent nickel; and ataxites have the greatest nickel content, 16 to 30 percent. Octahedrites exhibit a crystal pattern called a Widmanstätten pattern when sliced, polished, and etched with nitric acid. Hexahedrites show thin, parallel Neumann lines when etched. Ataxites show no Widmanstätten pattern or Neumann lines, because of their high nickel content.

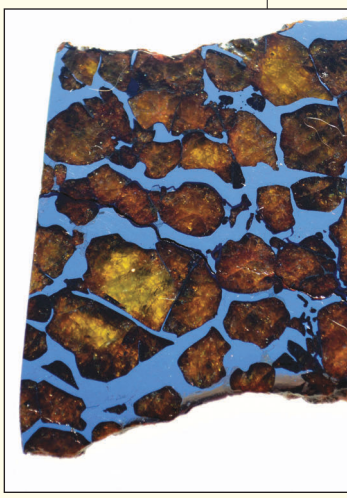
Iron meteorites are subdivided according to a chemical classification system using nickel and the trace elements gallium, germanium, and iridium to define distinct chemical groups. These groups are named IAB, IC, IIAB, IIC, IID, IIE, IIF, IIG, IIIAB, IIICD, IIIE, IIIF, IVA, IVB, and ungrouped irons.

Stony-irons comprise only 2 percent of meteorites and are divided into two categories: pallasites and mesosiderites. Stony-irons contain pieces of an asteroid's "stony" silicate mantle and its nickel-iron core. The origin of pallasites is controversial: they were once widely thought to represent the core-mantle boundary of an asteroid, but now seem more likely to result from large impacts in the early Solar System. Pallasites are arguably the most beautiful meteorites, containing gem-grade olivine (peridot) in a nickel-iron matrix. Mesosiderites consist of broken, angular fragments of mantle rock and nickel-iron that have been fused together by impact.

All meteorites—except interior pieces of those that broke apart after passing through the Earth's atmosphere—exhibit fusion crust on their exteriors. Fusion crust is a black, melted outer coating, which is evidence of atmospheric entry (Figure 3). Meteorites are designated as falls or finds. A fall is a meteorite that was actually seen to fall and was picked up immediately after impact. Falls are the most scientifically valuable meteorites since they are pristine, unaltered samples of extraterrestrial material. Finds are meteorites that were not seen to fall and are usually found accidentally. Finds have been "terrestrialized"—weathered and chemically altered—after being on Earth for an extended period of time. Finds will exhibit weathered fusion crust, which will not be as jet-black as the crust on a fall. Make sure the fusion crust is still visible and not totally weathered away: the presence of fusion crust on a meteorite adds

Figure 1: The three basic types of meteorites—stones, irons, and stony-irons. Left: Parnallee LL3 chondrite, which fell in the Madura district, Tamil Nadu, India, on February 28, 1857. Note the exquisite preservation of the chondrules, which were formed during the condensation of the solar nebula. Specimen is a partial slice weighting 5.5 grams and measuring 42 mm x 26 mm x 3 mm. Center: The Odessa IA coarse iron octahedrite was found in 1922 in Ector County, Texas. Note the Widmanstätten pattern typical of octahedrites. Specimen is an endpiece weighing 192.9 grams and measuring 65 mm x 60 mm x 15 mm. Rght: Stony-iron pallasites consist of gem-grade peridot (olivine) in a nickel-iron matrix and are the most stunningly beautiful of all the meteorites. Pictured is the Imilac pallasite found in 1822 in the Atacama Desert, Chile. Specimen is a partial slice weighting 64.4 grams and measuring 84 mm x 58 mm x 3 mm.



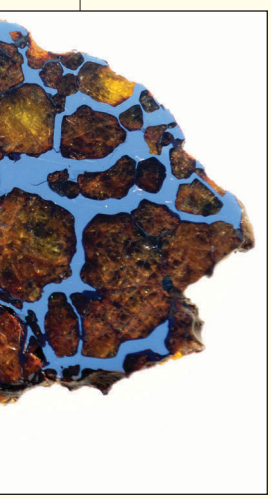


COLLECTING METEORITES

market value to the specimen. Meteorites are named after the locality from which they were collected. The Meteoritical Society has a nomenclature committee, which assigns every authenticated meteorite an official name (Table 1).

Meteorites are sold as individuals, endpieces, and slices. An individual is a complete, uncut meteorite. An endpiece is an individual that has been cut in half or in quarters. A slice is a cross-section of an individual. Slices can be further cut in half or in quarters and are then referred to as partial slices. A thinly cut slice will have a larger surface area than a thick slice of the same weight or mass, and therefore a thin slice will give you the largest size for your money.

The total known weight is also a consideration when purchasing a meteorite, because the total known weight will affect a meteorite's price. For example, was there only a single stone that fell, or many individuals? Do the known individuals total only a few pounds or kilograms, or over a ton? For example, the martian meteorite Zagami fell on October 3, 1962, in Nigeria. Only a single stone weighing 40 pounds (18 kg) exists on the entire planet Earth! Allende, a rare kind of meteorite called a carbonaceous chondrite, fell on February 8, 1969, in Chihuahua, Mexico. Many individuals have been collected, totaling over two tons!



Meteorites are usually sold by the gram. When purchasing a meteorite, take the cost and divide it by the total mass of the specimen to obtain the cost per gram. For example, a $50 specimen weighing 10 grams costs $5 per gram. Shop around, since dealer prices per gram of a meteoritic specimen can vary tremendously. Ordinary chondrites typically average from $1 to $5 up to $10 per gram. Falls typically cost more than finds since fallen meteorites are in more pristine condition. Irons are less expensive, typically averaging $0.10 to $0.50 up to several dollars per gram for individuals. Slices are typically priced at $1 or more per gram. Pallasites are pricey, up to $30 per gram. Mesosiderites are more affordable at $5 to $10 per gram. Lunar and martian meteorites are typically priced at several thousand dollars per gram! I would stay away from the rarer types of meteorites when first starting out. Once a collector has obtained the more commonly available specimens and is more knowledgeable in the field of meteoritics, then it's time to acquire the rarer specimens. As a collectable, meteorites appreciate in value over time. However, conventional holdings like stocks, bonds, and mutual funds are probably a much better long-term investment strategy.

Meteorite falls, especially historic falls, have the highest market value. An historic specimen is a witnessed fall associated with an interesting story. For example, a bright super-bolide visible in the sky over Russia on February 15, 2013, caused a series of shock waves that shattered windows, damaged thousands of buildings, and left some 1,500 people injured. Fortunately, no one died from this incredible meteorite impact. The meteorite was named Chelyabinsk and classified as an LL5 ordinary chondrite with a total known weight of over a ton (Figure 3).

The aesthetics of a meteorite is also a consideration when purchasing a meteorite. A full slice of a stone, iron, or stony-iron is preferable to a partial slice. Does the partial slice have a natural edge with fusion crust? I personally do not like a perfectly square or rectangular sliced meteorite. This particular cut looks very synthetic and unappealing to me. Iron meteorites typically exhibit regmaglypts—depressions that look like thumbprints—on their crusts, which adds aesthetic appeal. Regmaglypts are the result of ablation from atmospheric entry. Dealers will charge more for a meteorite that is aesthetically pleasing. Most of the time, this is well worth the money.

Table 1 lists several websites that are invaluable to the meteorite collector. When purchasing a meteorite, the buyer should be aware of some basics. The online auction site eBay is a good place to start. When deciding to purchase a meteorite, make sure the dealer is a member of the IMCA (International Meteorite Collectors Association). The IMCA ensures that members are experienced meteorite dealers and sell only authentic meteorites.

Ensure that the meteorite comes with proper documentation. An undocumented meteorite is almost worthless to a collector! All you know is that it is some type of stone or iron. But from where? What is the locality? What is its classification? Is it a fall or a find? What is the official name? Proper labeling is therefore essential. When purchasing a meteorite look for the specimen's official name, classification, fall or find, fusion crust present, total known weight, cost per gram, surface area (size), rarity, and overall aesthetic appeal of the meteorite. A detailed label will always be provided with a meteorite sold from an IMCA member.

Recent finds in the Sahara Desert in Africa have flooded the meteorite market. This is a good thing, since most of these meteorites are rather affordable for many people. Referred to as NWA (northwest Africa) followed by a number, they have been

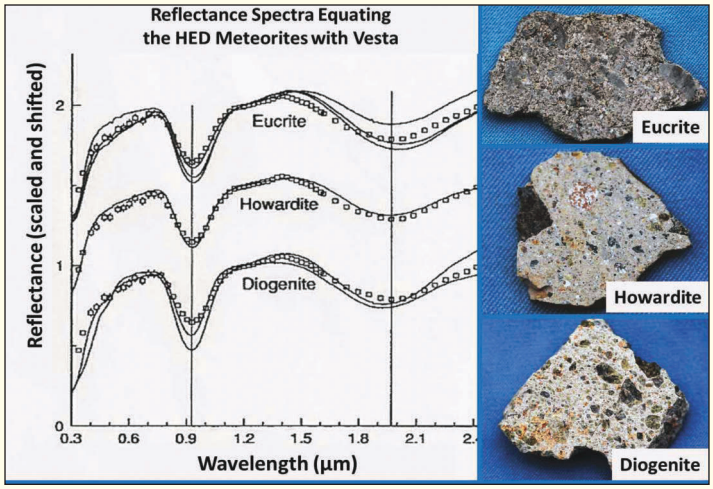


Figure 2: Telescopic reflectance spectrum of asteroid (4) Vesta (open squares) and laboratory bidirectional reflectance spectra of ground, powdered HED (howardite, eucrite, diogenite) meteorites (solid lines). The two vertical lines around 0.93 and 1.97 micrometers indicate the centers of two major absorption bands for pyroxene in the spectra of Vesta and the laboratory spectra of HED meteorites. The Dawn mission, which orbited asteroid Vesta in 2011–2012, has confirmed these findings. The HED classes are illustrated by the Juvinas eucrite, Johnstown diogenite, and NWA 982 howardite, all from the author's personal collection. Juvinas fell in Juvinas, Ardèche, France, on June 15, 1821; partial slice weighing 7.3 grams and measuring 44 mm x 27 mm x 3 mm. Johnstown fell in Weld County, Colorado, on July 6, 1924. Partial slice weighing 20.4 grams and measuring 33 mm x 33 mm x 8 mm. NWA 982 was found in Morocco-Algeria; partial slice weighing 2.0 grams and measuring 24 mm x 21 mm x 2 mm. Graph credit: Hiroi, T., Pieters, C.L., and Takeda, H., 1994, Grain size of the surface regolith of asteroid 4 Vesta estimated from its reflectance spectrum in comparison with HED meteorites, Meteoritics & Planetary Science *29(3), 394–396.*

Figure 3: The Chelyabinsk LL5 ordinary chondrite fell on February 15, 2013, in Chelyabinsk Oblast, Russia. Note the jet-black fusion crust of these individual meteorites. The price per gram has been steadily decreasing, so now is a good time to purchase this historically important meteorite. Note: if a better specimen comes along, go for it! The IMCA dealer I purchased these specimens from actually went to Chelyabinsk and obtained glass that was shattered by the shock wave as the meteorite entered the atmosphere. The glass fragment weighs 8.27 grams and measures 50 mm x 27 mm x 4 mm and was from the garden shed window of Chelyabinsk resident Denis Karpukhin. I cannot over-emphasize the importance of documentation when it comes to collecting meteorites. The largest central individual weights 20.8 grams and measures 30 mm x 27 mm x 20 mm.

collected by nomads in the desert. The NWAs first appeared on the meteorite market in the early 2000s. Most lunar and martian meteorites are NWAs.

A typical meteorite enthusiast is a "type" collector, meaning they collect at least one meteorite from each classification. For example, the ordinary chondrites consist of 12 main types (H3, H4, H5, H6, L3, L4, L5, L6, LL3, LL4, LL5, and LL6). Intermediary types also exist, such as H4–5. The NWAs are a great way to fill in the gaps in one's collection. For example, I had a difficult time obtaining an LL4 amphoterite for my personal collection. With the discovery of the NWAs, I was then able to obtain several LL4 meteorites.

Meteorites preserve valuable information regarding the formation of our Solar System. Their scientific significance also adds value to a meteorite for the collector. For example, a special type of stony chondrite called a carbonaceous chondrite is of special interest to science. The Allende CV3 carbonaceous chondrite (C stands for carbonaceous; V for Vigarano, the type specimen of this meteorite; and 3 indicates well-preserved chondrules) fell on February 8, 1969, at 1:05 p.m. local time in Chihuahua, Mexico (Figure 4). Over two tons of this rare type of meteorite have been recovered. Fortunately, Allende is readily available to collectors at $15 to $25 dollars a gram. This is a meteorite that should be in every amateur astronomer's collection. A 10-gram thinly sliced specimen will measure an inch by an inch (25 mm by 25 mm) or more. Allende contains white calcium-aluminum inclusions (CAI). These CAIs were the first silicate materials to have formed in the solar nebula. As the name implies, carbonaceous chondrites contain a higher proportion of carbon than ordinary chondrites. The carbon in Allende is mostly in the form of graphite, diamond, and fullerenes. The diamonds are only nanometer-sized and formed in the vacuum of space. The fullerenes or buckyballs occur as hollow C60 and C70 with entrapped extraterrestrial noble gases. Allende also contains organic carbon, which is carbon bonded to hydrogen, nitrogen, and oxygen. Polyaromatic hydrocarbons, essentially tar and formaldehyde (embalming fluid), have been detected in this extraordinary meteorite. Entrapped stardust in the form of silicon carbide indicates that a nearby supernova began the formation of our Solar System 4.6 billion years ago. All this in one very aesthetically pleasing meteorite!

Another must-have carbonaceous chondrite is the Murchison CM2 (C for carbonaceous; M for Mighei, the type specimen; and 2 for well-preserved chondrules). The Murchison meteorite fell on September 28, 1969 in Victoria, Australia (Figure 5). Only 220 pounds (100 kg) has been collected. The findings are similar to Allende with regard to carbon in the form of graphite, nanodiamonds, and fullerenes. Silicon carbide has

Figure 4: The Allende CV3 carbonaceous chondrite fell on February 8, 1969, in Chihuahua, Mexico. Note the calcium-aluminum inclusions, which were the first silicate materials to have formed in the solar nebula. Carbon in Allende is bonded to itself in the form of graphite, nanodiamonds, and fullerenes. Allende also contains organic carbon and polyaromatic hydrocarbons. Silicon carbide grains suggest that a possible nearby supernova began the formation of our Solar System. All this in one incredible meteorite! Complete slice weighing 32.7 grams and measuring 57 mm x 52 mm x 4 mm.

Figure 5: The Murchison CM2 carbonaceous chondrite fell on September 28, 1969, in Victoria, Australia. Note the chondrules, calcium-aluminum inclusions, and black phyllosilicate matrix. The matrix of Murchison contains approximately 12 percent water and contains organic carbon in the form of amino acids, fatty acids, sugars, and nucleotides. The carbon in this meteorite has yielded a wealth of information regarding the possible origins of life on Earth. Specimen is a 20-gram wedge-shaped endpiece measuring 33 mm x 29 mm x 14 mm.

also been detected in Murchison. The most incredible finding of the Murchison meteorite is that the organic carbon is in the form of biologically important compounds, such as amino acids, fatty acids, sugars, and nucleotides. Amino acids form the fundamental building blocks of proteins. Over 78 amino acids have been confirmed in the Murchison carbonaceous chondrite, of which 13 are of biological importance. Fatty acids form the basis of cell membranes. Sugars provide energy for biological systems. Nucleotides (adenine, guanine, cytosine, thymine, and uracil) form the bases of the DNA and RNA molecules. In short, the Murchison carbonaceous chondrite contains many of the fundamental building blocks utilized by all living organisms on Earth. Meteorites like the Murchison may have "jump-started" life on Earth! Given its scientific significance and low total known weight, Murchison does not come cheap. This meteorite typically sells for $150 to $300 per gram (for comparison, pure gold was selling for $43 per gram as of August 2016). Murchison is becoming more difficult to obtain, so I recommend purchasing up to a gram for your collection. Fortunately, this meteorite has a low density (is rather light) and a gram fragment will be a quarter an inch (6 mm) in size or so depending on the cut. Obtain a specimen that has fusion crust present, because its presence adds value to a meteorite. Murchison will cost you the equivalent of a high-end eyepiece or another telescopic accessory. Note that Allende and Murchison are also considered historic falls.

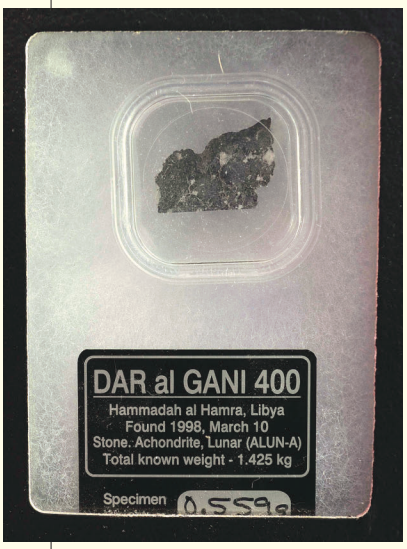


Figure 6: Smaller, rarer specimens are best preserved and displayed using membrane boxes in Riker mounts that are properly labeled. This Riker mount measures 11 cm x 80 cm x 20 cm. Dar al Gani 400 is a lunar anorthositic breccia. The white clasts are composed of the mineral anorthosite, which is predominant in the lunar highlands. Anorthosite gives the Moon its whitish appearance, whereas the basalts comprising the maria are a darker gray.

The year 1969 was a significant one in the world of science. On February 8, 1969, the Allende CV3 carbonaceous chondrite fell in Mexico; we landed on the moon on July 21, 1969; and on September 28, 1969, the Murchison CM2 meteorite fell in Australia. Sandwiched between all these events was the Woodstock music festival in New York, August 15–17, 1969. Peace, man!

The holy grail for meteorite collectors have been the lunar and martian meteorites. Most of these meteorites have been found in the Sahara Desert and the Middle East. Lunar and martian meteorites typically start at a thousand or more dollars per gram. Fortunately, most are partial slices that are sliced very thin (less than 0.1 inch, 1 to 2 mm) and are therefore more affordable to the collector. Lunar meteorites are of two basic types: anorthositic highland breccias and lowland volcanic basalts. Martian meteorites are referred to as SNCs (pronounced "snicks"). SNC stands for shergottite, nakhlite, and chassignite, after the type specimen in each of the three classes of martian meteorites. I recommend collecting these meteorites only when you have a solid foundation in the hobby and have the financial means to invest in lunar and martian real estate.

Table 1: Starting a Meteorite Collection

Internet Sources
eBay is a good start (but let the buyer beware!): *www.ebay.com*
International Meteorite Collectors Association (IMCA): *www.imca.cc*
Meteorite Collector: *www.meteoritecollector.org*
The Meteorite Exchange: *www.meteorite.com*
Meteorite Information: *www.meteorite-information.com*

Academic
Online, free meteorite magazine: *www.meteorite-times.com*
Meteorite Studies: *www.meteoritestudies.com*
Meteoritic Society: *www.lpi.usra.edu/meteor*
SAO/NASA Astrophysics Data System: *adsbit.harvard.edu*

Lunar
Meteorites: meteorites.*wustl.edu/lunar/moon_meteorites_list_alumina.htm*
Martian Meteorites: *www2.jpl.nasa.gov/snc/ and www.imca.cc/mars/martian-meteorites.htm*

Supplies
Aluminum Labels: *www.meteoritelabels.com*
Hoppe's No. 9 lubricating oil (product number 1003): *www.amazon.com*
Eva-Dry E-333 Renewable Mini Dehumidifier: *www.amazon.com*
Membrane boxes: *www.membranebox.com*

The preservation of meteorites is an important aspect of collecting. The air on Earth, rich in oxygen and water vapor, is a hostile environment for meteorites. The metal flakes in ordinary chondrites readily rust over time. I recommend keeping stony meteorites in a plastic bag with Eva-Dry E-333 renewable mini-dehumidifier. This keeps the humidity low and delays the inevitable rusting of sliced stony meteorites.

Iron meteorites are best preserved using Hoppe's No. 9 lubricating oil (product number 1003). This oil is colorless and odorless and will not discolor or gum over time. Apply the oil to an iron meteorite, then place it in a plastic Ziploc bag. Double bag it to prevent leakage of the oil. In time, the oil finds its way out, so one must change the oil every six to twelve months. Use the same technique for stony-iron pallasites and mesosiderites. The oil will not harm the pallasitic olivine crystals.

Meteorites are best displayed with a Riker mount, membrane box, and label (Figure 6). Membrane boxes contain a thin membrane that suspends a specimen, exhibiting both sides of a meteoritic slice. Reserve membrane boxes for small, rarer meteorites. I do not recommend starting a collection of micro-mounted meteorites that fit into 39 mm x 39 mm x 18 mm membrane boxes. One will pay more per gram for the meteorite! For example, if you purchase a small one-gram micro-specimen of Allende, you can pay up to $50 for the specimen. That is $50 per gram. Typically, $50 worth of Allende will give you 3.3 grams of meteorite at $15 per gram. It is always preferable to have the largest specimen you can afford. A good size to shoot for is a meteoritic slice that fits in the palm of your hand.

Finally, beware of meteorite-related material being passed off as an authentic meteorite—for example, tektite-meteorite, impactite-meteorite, or shatter cone–meteorite. These are not meteorites themselves but meteorite-related materials that

Continued on page 27

Gregory T. Shanos, Pharm.D., is a pharmacist by profession and NASA Solar System Ambassador by passion. He is a member of the Museum Astronomical Resource Society (MARS), Local Group of Deep Sky Observers (LGDSO), and the St. Petersburg Astronomy Club (SPAC) in Florida. Dr. Shanos became an amateur astronomer in 1985 with the apparition of Halley's Comet. His passion for meteorites began a year later when *Sky & Telescope* advertised authentic meteorites for sale. After purchasing three iron meteorites for a total of $60, he was hooked for life! Dr. Shanos has also published over 30 review articles in *Meteorite* magazine regarding organic compounds in meteorites.
Note: All the featured meteorites are from the author's personal collection. Photos by the author.

Dealt Anew

What if it were true, as most ancients believed, that nothing in the sky ever changed? Though their planets "wandered," the rest of the celestial sphere seemed inanimate, with only rare novae and supernovae to hint at a more complex, subtle reality. Deep respect for famed philosophers such as Aristotle blinded many to not only the necessity of change, but also its importance. The sky was alive with motion and volution, abundant with fusion and exchange, but the clues that would open understanding were mostly ignored in favor of a preferred status quo. We know now that nothing we see in the sky, or our very existence on this planet, would be possible without those essential processes. The signs were present, but it took a series of observations and daring ideas by rational thinkers to alter the stolid acceptance of an entrenched immutability. As observers of the sky, what can we see of this legacy of change? Where are the visible counterparts of an evolving cosmos?

In modern science, the twenty-four letters of the Greek alphabet designate multiple principles and constants, but a few stand out in importance. The fourth letter, delta, often symbolized by a triangle, is best known as meaning change. Alpha, the first letter, is associated with a type of radiation, the strength of electromagnetic interaction, and the name for a dominant individual. Nu, the thirteenth letter that is shaped like our "v," denotes frequency, degrees of freedom, and may be an adjectival homonym. Epsilon follows delta, and is used for elasticity, axial tilt, and planetary rings.

Creative minds seek new and alternative ways to represent associations and ideas. The work of certain artists, musicians, and sculptors draw the rest of us forward to places we may not have gone without their vision and talent. Eike Schmidt, the head of decorative art at the Minneapolis Institute of Art, commented on a piece displayed at his 2015 exhibition, "The Hapsburgs." The sculptor Leonhard Kern carved a walrus tusk, circa 1643, into "Abundantia," the Roman personification of prosperity, with the hand of her nude form resting on a rising cornucopia. Schmidt noted that art theory of the time equated creation with procreation, and by changing nature (the tusk), one could show how fertile soil (the ground, a woman) could produce change (abundance in food, humanity).

One of the most striking representations of change I've encountered is the radical Italian sculptor Gian Lorenzo Bernini's depiction of Apollo and Daphne, where the god's unwanted attentions force the nymph to pray that her father revoke her beauty, and "change the body that destroys my life." She is thus turned into a laurel tree before our eyes, denying Apollo his prize. This story from Ovid's *Metamorphoses* was the last work commissioned by Cardinal Scipione Borghese, and is displayed at his villa just outside the walls of Rome. Ironically, Apollo's light would feed these leaves used to wreathe the heads of poets and artists to honor their achievements.

One Greek philosopher glimpsed the essence of change. Heraclitus encapsulated it in his elegant phrase, "No man ever steps in the same river twice." In light of modern knowledge of our Cosmos and the quantum realm it is reasonable to ask, "What does not change?" Stars, planets, solar systems and stellar clusters, and galaxies and groups of galaxies evolve and interact. Even the expansion of the Universe appears to change. But the positive energy of change to create form has a dark side. From Stephen Hawking we know black holes evaporate, and nuclear theory posits protons to decay. Some particles of light and matter may survive to near eternity but, if our understanding of the power of dark energy is accurate, the Universe is fated to expand into oblivion, with its ultimate end a random, separated collection of disconnected subatomic pieces and electromagnetic energy. Since we are awash in change, let us attempt to see those vary things.

Our atmosphere is in constant flux. Humidity, wind, dust, clouds, turbulence, and the seasonal patterns of temperature and light affect observing. Available targets range in and out of view as the months roll by. Lives change in health, age, interest, equipment, and opportunity. Total eclipse pursuits are exciting, but require meticulous planning and moderate expense. A lifelong dream of extended Southern Hemisphere observing needs to happen in the next few years, before unstable age has its sway.

The Moon is a constantly changing target available to everyone, with naked-eye and binocular views as rewarding as those through a telescope. Stellar and planetary occultations provide drama and scientific value. The motions and transits of planets, their satellites, asteroids, and the atmospheric alterations in Mars, Saturn, Jupiter, and the outer gas giants reward repeated viewing. Though rare, few sights are more inspiring than a great comet arcing across a dark country sky. Sometimes, as with Comet Holmes or Chelyabinsk, unexpected collisions provide spectacular results. Meteor Crater in Arizona and the smaller version outside Odessa, Texas, remind us we are all potential future dinosaurs.

The Sun is the source of our biosphere's energy and, with its cycle, sunspots, and flares, an endlessly fascinating object of study. New filters allow access to more of its secrets. One of my best friends is a variable star observer, an avocation of scientific merit. A few of the nearer stars show proper motion visible over human lifetimes, such as ninth magnitude Barnard's star in Ophiuchus. A brown dwarf I observed in 2006, DENIS-P J1441-0945 in Libra, moved many arcseconds to the south-southeast between the two Palomar Sky Survey images separated by forty years. Patient, repeated observation can document such change.

A number of nebulae show their dynamic nature through variation or expansion. The Crab Nebula in Taurus, M1, is engaging for many reasons. Its growth over time, visible in images taken decades apart, is potentially observable to the amateur through careful drawing. Its central, energizing pulsar is a neutron star that rotates thirty times a second, sending out a beam of light that makes it the only pulsar visible to amateurs. Its blinking can be captured by imaging, and has been reported visually using a variable speed occulting device between the secondary mirror and the focuser. I observed Tycho's and Kepler's supernova remnants a decade ago, and their positions are perceptibly different from archival images taken in the 1940s and 1970s. Many nebulae are associated with variable stars, such as Hind's Variable Nebula, NGC 1555 in Taurus. It is illuminated by T Tauri, the prototype star of its class of early solar system–forming objects. In January 2004, my friend Jay McNeil captured the variable nature of a pre–main sequence star near M78 in Orion. This fortunate, rare event was seen on an image taken with his three-inch refractor, when his keen eye and knowledge of the area's appearance allowed him to appreciate it as a new object and notify the astronomical community. It is now classified as a cometary reflection nebula.

Many artists become adept at faithfully representing details of nature, but a few progress past the depiction of what can be seen to a level beyond the apparent, to plumb depths of connection and meaning not obvious to others. It is as though they have been given a special key to unlock areas to which only a small number are privileged to travel. Claude Monet was such an artist, who late in his career produced works that appeared, in Maximillian Potter's terms, "organic" and "deep," as an attempt to explore what he saw as

an interweaving of our reality with a spiritual plane. In his book, *Shadows in the Vineyard*, Potter describes the aspirations of one of the world's most accomplished vintners, Aubert de Villaine of Domaine de la Romanèe-Conti in Burgundy. As a young man he wished to study poetry and philosophy, and resisted what he later accepted as his destiny: to care for his vines and produce what many consider the world's most magnificent wine. As Potter so aptly put it, like his beloved pinot noirs, de Villaine "matured within the bottle of his skin," accepting the work produced by his unique skill and experience as his highest purpose. As Monet had found "a liquefied oneness, filling the canvas for others to drink in, and experience the divine," de Villaine's life "had been dedicated to transcending the technical and vinifying nature's invisible energy." Almost twelve score years after a certain declaration of independence, the dependence of all matter on another field of invisible energy was declared certain. On July 4, 2012, the discovery of the Higgs particle confirmed a hypothesis proposed a half century earlier. Peter Higgs, and others, offered that a field of energy (later called the Higgs field in his honor) suffused all of space, and that its decay conferred mass onto particles such as protons and electrons. Without it there would be no matter, or us.

In 2002 the dazzling new object V838 Monocerotis appeared, and its journey of light through its surrounding nebula was fascinating to follow through the eyepiece. The Hubble Space Telescope documented the intricacies of its bounding, bouncing radiation, and much of its detail was visible in my 25-inch reflector. Though its origin is still debated, many think its energy flash was the result of a stellar collision. Stars sometimes produce much larger and more violent displays. About fifty extragalactic novae were spotted in 2015 out to distances of dozens of light years. These brightened to between fifteenth and eighteenth magnitude, well within the visual range of amateur reflectors. Advances in astrometrics and imaging have allowed recovery of "light echoes" similar to V838 Monocerotis from supernovae centuries after their first appearance, as their indirect paths of reflected light off interstellar clouds delayed their arrival. I attempted visual observation of echoes found in 2008 from Tycho's supernova remnant and Cassiopeia A, but they were too faint at 23rd magnitude, and that search will require a closer or brighter counterpart. In 2006 I observed the nebula of supernova 1993J in M81, an object documented to fade from 18th to near-20th magnitude over the ten years after its appearance. Its light echoes, invisible to me, were imaged by Hubble. Supernovae are visible to hundreds of millions of light years, and gamma-ray bursts, which are supernovae with their jets aimed directly at us, can be seen with amateur equipment to distances of billions of light-years. On March 19, 2008, the intrinsically brightest explosion ever recorded was found from a gamma-ray burst in a galaxy 7.5 billion light-years away. That event from halfway across the visible Universe briefly attained naked-eye brightness, though no one has claimed its visual sighting.

The longer I study the Universe, the more it appears as a grand composition, with each object a unique brushstroke. Far from being an unchanging, isolated canvas, it seems most comprehensible as a dynamic testament. As the Impressionist Monet stated, "A landscape hardly exists at all as a landscape because its appearance is changing in every moment. But it lives through its ambience, through the air and light, which vary constantly." We may agree with the artist that our journey of inevitable change helps us "to view the world from a different dimension" and see "the flicker and flow of energy among all natural things."

Dave Tosteson
Chisago City, Minnesota
djtost1@gmail.com

10, 25, and 50 Years of the Astronomical League's Magazine

By Mike Stewart, Astonomical League Historian

November 1966

1966 Perseid Meteor Watch

The 1966 Perseid meteor shower was well observed by the Astro-Gators Astronomy Club, a junior group in Jacksonville, Florida. On the night of the maximum, August 11–12, 1966, we held a meteor watch at a local church. First on the agenda was a cook-out which everyone enjoyed immensely. Our observing equipment was then set up and observations began shortly after nightfall under nearly overcast skies.

Shortly after midnight the sky cleared completely, and we witnessed an unforgettable cosmic fireworks display. Meteors came thick and the friendly mosquitoes were soon forgotten in the struggle to record our observations. One bright fireball really thrilled us all when it left a cloud of smoke that endured for twenty-five seconds.

We observed jointly for the IGY Meteor Centre in Ottawa, Canada, and the American Meteor Society. Our group recorded over 1,200 meteors, most of which were Perseids.

September 1991

Tales of the Unknown Astronomer

It was late. The stars were so bright they almost put you into a trance. We had been working our telescopes so hard the Teflon smoked, and it was time to take a break. Taking a walk loosens up the bones and helps to get the blood flowing again, so it was off down the telescope field to see what the rest of the star party was up to, and to see who was still up.

As we walked around by starlight, you can't help but notice that familiar scenes in the daylight take on a much different and eerie appearance at night. Over in one corner, this star party had a clump of eight telescopes that had tubes at least eight feet long. Their barrels were all pointing to different parts of the sky, producing the impression of a forest of telescopes. As we talked toward the area we saw little Annie walk away from one group of telescopes and disappear into the forest of large scopes.

My friend casually remarked, "It looks like Annie entering Wonderland!" After a moment, as we came closer, he re-thought the matter. "No, it looks more like a valley of large telescopes!"

Almost immediately, another friend who had overheard said in his eeriest voice, "Yeah, though I walk through the Valley of Large Telescopes," and someone else from the other side of the area followed with, "I shall fear no evil." That did it! For the next hour or so, everyone in the area jumped in and put in his own two cents worth.

December 2006

The Astronomical League at the Sally Ride Science Festivals

October 1–2, 2006, became a flurry of activity for Astronomical League President Terry Mann and member Tammy Plotner as they set sail for Michigan to participate in two Sally Ride Science Festivals.

As the first U.S. woman in space, Sally Ride has dedicated herself and her projects towards steering young women toward science-minded careers. The objective of each festival is to give participants an opportunity to sample science in workshops. The TP Universe [workshop] was presented by Terry Mann.

Workshops aren't all there is to the festivals. Open to the public and registrants is the Street Fair, where each group displays hands-on activities and enters into one-on-one conversations and demonstrations. The Astronomical League was well represented in a colorful and interesting fashion.

Not a single face passed by that didn't spend some time with both Terry and Tammy as they explained everything from why the Moon has phases to the recent debate on Pluto. For more than five hours the team kept busy as the kids kept coming. Both questions and answers flew as our team smiled and enjoyed the excitement. So many took more than just a passing interest in what we had to say and display—they kept coming back for more.

In just two days, the Astronomical League reached a total of 974 visitors. Be sure to look for other such venues in your area to practice outreach.

You'll be glad you did!

FROM AROUND THE LEAGUE

Call for League Officer Nominations

The two-year term of the office of secretary ends on August 31, 2017. If you are interested in using your talents to serve in this important position, we would like to hear from you. Please volunteer!

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

Each candidate should send a statement explaining why they are interested, along with a photo of themselves for publication in the *Reflector*, to nominating committee chair Bill Bogardus, *vicepresident@astroleague.org*. Please limit all statements to approximately 250 words. All nomination materials must be submitted by March 15, 2017.

Astronomical League's Youth Awards 2017

Time to apply! Each year, the Astronomical League awards thousands of dollars to young astronomers with five major awards. Now is the time to start considering the AL youth awards for 2017: the National Young Astronomer Award, the Horkheimer/Smith and Horkheimer/D'Auria Youth Service Awards, the Horkheimer/Parker Youth Imaging Award, and the Horkheimer/O'Meara Journalism Award.

NYAA: If you know of any young person, age 14–19 at the time of application, who has been involved in an astronomy-related research project, either on their own or through an educational institution, please consider nominating that person for the National Young Astronomer Award.

The Horkheimer/Smith and Horkheimer/D'Auria Youth Service Awards: If you know of a League member age 18 or younger who has brought amateur astronomy to your club or to the public through outreach, presentations, writing, or observing, please consider nominating that person for the two Horkheimer Youth Service Awards.

The Horkheimer/O'Meara Youth Journalism Award: The competition is open to young writers age 8–14. Submissions should be 300 to 500 words. We do not limit the entries to astronomy-related topics; we are open to any science-related topic that interests the contestant—robin's eggs, quasars, you name it!

The Horkheimer/Parker Youth Imaging Award: This is open to any young astrophotographer age 18 or younger.

Note: due to unusual circumstances of our calendar for 2017, we are moving the deadline for all AL youth awards to February 15, 2017.

If you are a club officer, please nominate deserving candidates. Information about each award can be found at *astroleague.org/al/awards/awards.html*.

Master Observer Progression—Big News, *by Aaron Clevenson*

The Astronomical League's Observing Programs have come a long way since their humble beginnings in 1967 with the Messier Observing Program. Today there are over 50 different Observing Programs, and six levels in the Master Observer Progression: Observer, Master Observer, Advanced Observer, Master Observer–Silver, Master Observer–Gold, and Master Observer–Platinum.

The Astronomical League is excited to announce our first and only platinum-level observer: congratulations to Brad Young of the Astronomy Club of Tulsa on being the first Astronomical League member to earn the Master Observer–Platinum Award!

The Master Observer Progression is designed to provide a path for lifelong learning and observing in the art of astronomy. The Observer Award is the first step and recognizes those who have completed five introductory-level Observing Programs: Constellation Hunter (either northern or southern), Messier or Binocular Messier, Lunar, Solar System, and a fifth program of the member's choosing (from among Galileo, Sketching, Sky Puppy, Two in The View, Universe Sampler, or Urban).

Master Observer remains unchanged from its inception in 2001. A member must complete ten Observing Programs, including Messier, Binocular Messier, Lunar, Double Star, Herschel 400, and five more top-level Observing Programs of the member's choosing. The Master Observer Award is independent of the progression, and the Observer Award is not a requirement.

New levels beyond the Master Observer Award have been added to recognize those members who have continued to earn new certificates and learn about new types of objects and new observing skills. As a prerequisite, they require both the Master Observer Award as well as all lower levels in the Master Observer Progression. The Advanced Observer Award recognizes achievements in observing specific types of astronomical objects, completing a total of 15 Observing Programs. The "metal" levels of the Master Observer Progression—silver, gold, and platinum—continue the recognition for those completing specific Observing Programs and with totals of 20, 30, and 40 certifications, respectively.

Most requirements for all levels in the Master Observer Progression involve earning the top level of each Observing Program. For more information, review the details on the Astronomical League website at *www.astroleague.org/content/master-observer-progression* or contact Aaron Clevenson, coordinator of the Master Observer Progression, at *aaron@clevenson.org*.

Los materiales seleccionados de la Liga Astronómica en español…Selected Materials of the Astronomical League in Spanish

The Astronomical League would like to make selected materials available in Spanish. These include the descriptions and instructions for some of the basic Observing Programs, and the most popular AstroNotes and Outreach Downloads. (All Observing Program submissions must continue to be written in English.) We need translators who could provide accurate and grammatically correct translations from English to Spanish. If you are interested in helping with this special project to bring amateur astronomy to more people, please contact Astronomical League president *John Goss, president@astroleague.org*.

Telescopes Needed for Public Sessions at AstroCon 2017

AstroCon 2017 organizers are seeking interested people who would like to share the dark night sky by providing and staffing telescopes for public viewing sessions. Telescopes are also needed for solar viewing. With upwards of 20,000 people expected to descend on Casper, Wyoming, next August, many folks surely would appreciate a view of the sky's wonders through a quality telescope.

Please contact Alan Corey, *alancorey1979@msn.com*, for complete details. This is a great opportunity to reach the public!

Big Day for the Atlanta Astronomy Club

3 new Master Observers

Left to right: Marie Lott, David Whalen, Valorie Whalen

The Astronomical League–Astronomics Sketching Award

Sketching the impression of a celestial scene allows the observer to see more detail and to better enjoy our amazing avocation. Why not try your hand at sketching tonight?

The Astronomical League is administering a new award program, the Astronomics Sketching Award. First place sketcher receives a cash prize of $250, second place $125, and third place $75!

For all the exciting details, please visit the Astronomical League awards page, *www.astroleague.org/al/awards/awards.html*.

This program is made possible through the vision and generosity of Astronomics, *www.astronomics.com*!

A New Astronomical League Program: The Astronomical League–OPT Imaging Awards

Oceanside Photo and Telescope has always been a good friend to amateur astronomy and to the Astronomical League. They have now enthusiastically offered to sponsor a new AL award program, the OPT Imaging Awards.

The AL recognizes the efforts of imagers with a program where they can submit their best work in four categories:

1. **Solar System Award:** featuring the Moon, Sun, planets, or comets
2. **Deep-Sky Award:** showing star clusters, nebulae, or galaxies
3. **Wide-Field Award:** capturing constellations, the Milky Way, aurorae, meteors, or planetary conjunctions and groupings
4. **Video/Time-Lapse Award:** showing movement in the heavens

Each category will have a first, second, and third place. First-place winners will each receive a $250 gift certificate from **Oceanside Photo and Telescope**, second place winners will each receive a $125 gift certificate, and third place winners will each receive a $75 gift certificate.

Please see *www.astroleague.org/al/awards/awards.html* for complete details of this exciting new program!

Reflector Update

There have been several questions regarding the *Reflector* formats, paper and digital. Subscribers have the option of choosing paper, digital, or both versions. Every member automatically receives a digital copy, and by clicking on the link received with the digital edition, members can opt in to receiving paper, opt out of receiving digital, and update their email information. You can also choose to receive both paper and digital versions.

Some benefits of the digital edition include:

* Receiving copies at least 1–2 weeks before paper subscribers
* Ability to zoom in or out of any page or image
* Using active hyperlinks to immediately go to a website or email address
* Reducing the printing and mailing costs of the magazine

Remember: paper and digital versions are available to all members. Just let your ALCor know which you prefer—paper, digital, or both.

Honorary Members of the Astronomical League

The Astronomical League appreciates the efforts of the many people who make astronomy happen. The hard work of these individuals, whose names are often well known to those in our hobby, frequently goes unsung. We like to recognize them by presenting them with an Honorary membership. This allows them to follow the activities of the Astronomical League and its members by receiving a complimentary subscription to the *Reflector* magazine.

We thank them for positively affecting all our lives by enhancing our time spent under the stars!

2016 Honorary Members

David Eicher, editor of *Astronomy* Magazine
Guy Ottewell, creator of the *Astronomical Calendar*
Scott Roberts, founder of Explore Scientific

Astronomical League Observing Programs

Active Galactic Nuclei Program
Advanced Binocular Double Star Observing Program
Analemma Observing Program
Arp Peculiar Galaxies Northern Observing Program
Arp Peculiar Galaxies Southern Observing Program
Asterism Observing Program
Asteroid Observing Program
Binocular Double Star Observing Program
Binocular Messier Observing Program
Binocular Variable Star Observing Program
Bright Nebula Observing Program
Caldwell Observing Program
Carbon Star Observing Program
Comet Observing Program
Constellation Hunter Observing Program (Northern Skies)
Constellation Hunter Observing Program (Southern Skies)
Dark Nebulae Observing Program
Dark Sky Advocate Observing Award
Deep Sky Binocular Observing Program
Double Star Observing Program
Earth Orbiting Satellite Observing Program (EOSOC)
Flat Galaxy Observing Program
Galaxy Groups & Clusters Observing Program
Galileo Observing Program
Globular Cluster Observing Program
Herschel 400 Observing Program
Herschel II Observing Program
Hydrogen Alpha Solar Observing Program
NEW Imaging Program
Local Galaxy Group & Galactic Neighborhood Observing Program
Lunar Observing Program
Lunar II Observing Program
Master Observer Award
Messier Observing Program
Meteor Observing Program
NEO Observing Program
Occultation Observing Program
Open Cluster Observing Program
Outreach Observing Award
Planetary Nebula Observing Program
Planetary Transit Special Observing Award
Radio Astronomy Observing Program
Sketching Observing Award
Sky Puppy Observing Program
NEW Solar Eclipse Special Observing Award
Solar System Observing Program
Southern Skies Binocular Observing Program
Southern Sky Telescopic Observing Program
Stellar Evolution Observing Program
Sunspotters Observing Program
Two in the View Observing Program
Universe Sampler Observing Program
Urban Observing Program
Variable Star Observing Program

League Regional Chairs

GLRAL (Great Lakes Region): Ron Whitehead, *executivesecretary@astroleague.org*
MARS (Mountain Astronomical Research Section): Wayne Green, *dxwayne@gmail.com*
MERAL (Mid-East Region): Terry Trees, *treest@comcast.net*
MSRAL (Mid-States Region): James Small, *webmaster@slasonline.org*
NCRAL (North-Central Region): Gerry Kocken, *gerryk@kockenwi.com*
NERAL (Northeast Region): Maryann Arrien, *Arrien@optonline.net*
NWRAL (Northwest Region): Gene Dietzen, *gene.dietzen@gmail.com*
SERAL (Southeast Region): Richard Schmude, *schmude@gordonstate.edu*
SWRAL (Southwest Region): David Moody, *bicparker@mac.com*
WRAL (Western Region): Wayne Johnson, *mrgalaxy@juno.com*
IRAL (International Region): John Wagoner, *john@alintlregion.com*

The Astronomical League Just Gave Away Ten Library Telescopes!

Through the vision of the **Horkheimer Charitable Fund**, the Astronomical League again offered a free Library Telescope to a lucky Astronomical League club in each of the ten AL regions.

The Library Telescope consists of an Orion 4.5-inch StarBlast Dobsonian (or equivalent), a Celestron 8–24 mm zoom eyepiece (or equivalent), and a nameplate commemorating the late Jack Horkheimer. The value of the package is approximately $300; the potential of the program is enormous.

The Library Telescope Program was initiated by the **New Hampshire Astronomical Society**. Clubs donate an easy-to-use, portable telescope with quality optics and a sturdy mount to their local library. Patrons can then check it out as they do books. Full details of this wonderful program can be found at *www.astroleague.org/content/library-telescope-program*.

The winning entry for each region was drawn and announced at ALCon 2016 in

Arlington, Virginia. The telescope, eyepiece, and commemorative plate were shipped to the winning clubs in the three weeks following ALCon.

Thank you **Horkheimer Charitable Fund**, **Orion Telescopes**, and **Celestron** for making this wonderful program possible!

Congratulations to the 2016 winning clubs:

South Shore Astronomical Society, NERAL; **Blue Ridge Astronomy Club**, MERAL; **Alachua Astronomy Club**, SERAL; **Toledo Astronomical Association**, GLRAL; **Popular Astronomy Club**, NCRAL; **Broken Arrow Sidewalk Astronomers**, MSRAL; **Longmont Astronomical Society**, MARS; **Fort Worth Astro-nomical Society**, SWRAL; **Tulare Astronomical Association**, WRAL; **Island County Astronomical Society**, NWRAL

Congratulations to the 2016 Astronomy Day Winners!

Large Metro Area, $150: **Northern Virginia Astronomy Club**
Medium Metro Area, $150: **Oglethorpe Astronomical Association**
Small Metro Area, $150: **Popular Astronomy Club**
Quality Events Year After Year, $50: **Kalamazoo Astronomical Society**
Best New Idea, $50: matching Starry Safari constellations to confiscated illegal pets: **Travelers Science Dome at the Gengras Planetarium**, West Hartford, Connecticut

Astronomy Day presents an excellent opportunity to increase science awareness in an interested but often misinformed public, to spark interest in the young, and to promote your club, all simply by personally introducing people to the wonders encountered in amateur astronomy. Look on the AL website for these helpful Astronomy Day materials: Astronomy Day Handbook, Outreach Downloads, and solar eclipse glasses.

If you would like to help administer this great program of bringing astronomy to the people, please contact Gary Tomlinson, *gtomlins@sbcglobal.net*.

AL Creates New International Region

The Astronomical League, in response to astronomy clubs from all over the world wanting to participate in the League's Observing Programs, is delighted to announce the creation of the new International Region. The purpose of the new region is to give international clubs access to our Observing Programs without having to worry about the administration, election of officers, and other details that come with running a region, but on a worldwide basis.

So if you know of an astronomy club outside of the United States and its territories that would like to be a member of the Astronomical League and enjoy our great Observing Programs, have them contact John Wagoner, International Region chair, at *john@alintlregion.org*.

2017 Mabel Sterns Newsletter Editor Award

The **Mabel Sterns Newsletter Editor Award** recognizes the work of Astronomical League club newsletter editors across the country. The deadline for nominations is quickly coming to a close on April 1, 2017 (no fooling). Nominations from the president or vice president of an Astronomical League–affiliated club should explain why their newsletter editor should be considered for the award.

Please email entries to *SternsNewsletter@astroleague.org*. The nomination should include:

- Name and postal address of the newsletter editor
- A recent issue of the newsletter in Adobe PDF or a link to it
- A photo of the editor, preferably in an astronomical setting (JPEG, please)
- URL of the club's website where electronic copies of recent newsletters are posted (along with any necessary passwords) would be welcome and helpful
- Name and city of the club

Both the nominating officer and newsletter editor must appear on the AL roster.

If electronic submission is not possible, four (4) paper copies of the letter of recommendation and newsletter may be mailed to the League's national office. One photo is sufficient.

Observing Programs Gold Anniversary, 1967–2017

On January 13, it will be fifty years since the Astronomical League awarded its first Observing Program certificate when **Catherine Delaney** of the Amateur Astronomers Association of Pittsburgh received her **Messier Club** certificate. Today, with over fifty separate Observing Programs to choose from, League members have earned over 10,000 observing certificates.

R. C. Dickensen, President of the A.A.A. of Pittsburgh presents certificate to Miss Catherine Delaney

MESSIER CLUB SUCCESS!

On January 13, 1967, the first certificate for membership in the Astronomical League's Messier Club was given to Miss Catherine Delaney of the Amateur Astronomers Association of Pittsburgh for having seen 71 objects from the Messier Catalogue and recording dates of observing them with her 6-inch Newtonian reflector telescope with a 46-inch focal length, using a one inch Kellner eyepiece.

Miss Delaney writes: "In 1961 because of the amount of snow which made observing almost impossible but wishing to do something in astronomy, I used the Norton Star Atlas and by using the brighter stars I sketched the location of each of the Messier Objects by triangulation or extended lines. As I observed each object I recorded the date of the first observation along the margin of the note book beside the sketch. I also recorded my personal observation of each object. For most of the objects I used my sketches to locate them but in the case of M72-73, I used the drift method suggested by Walter Scott Houston in the Sept. 1961 Sky and Telescope in which alpha Capricorni is brought into the eyepiece, lock it in, and wait for 36 minutes, M72, a faint globular cluster crossed the field (seen with averted vision) followed shortly by a small configuration of stars known as M73.

Seven of the Objects I have seen only once, eleven others I have seen from two to five times, the remainder I have seen many times, M 13 an even 200 times.

It has taken me three years to observe the 71 objects.

I have classified the objects as E for Excellent, G for Good, F for Fair and P for Poor, also the conditions of the sky in which they could be seen, from 1 to 5; 1 being a poor sky and 5 being the best possible sky in Pittsburgh. For example: M1, I classified as F needing a 4 to 5 sky, this after 24 observations; M51—F-5 after 14 observations."

Miss Delaney, a Northerner, was the first recipient but the next six are from sunnier climes:

Certificates for 70 Objects issued to:
Steve Hall — Dallas, Texas
Kurt Alback — Dallas, Texas

Certificates for all 107 Objects to:
Karl Simmons — Jacksonville, Fla.
John H. Wulf — Dallas, Texas
David Gordon — Dallas, Texas
Ronnie Price — Dallas, Texas

It is recommended that the League's logo be displayed in the newsletter, preferably on the front page. Awardees and their clubs must be AL members.

Entries will be judged by a panel of previous winners. For further information, please see *www.astroleague.org/al/awards/sterns/sternss.html*.

Seeking Lost Issues of the *Reflector*

For the past several years, the League has been collecting copies of all past issues of the *Reflector*. Readers see the covers of three of these past issues in every new issue, on the "10, 25, and 50 Years" column. We have most past issues, but are missing the following: **March/April 1958**, **May/June 1958**, and **November 1980**. If any of our members have any of these, please contact Ron Kramer at *managingeditor@astroleague.org*. We would arrange to scan the entire issue and return it to its owner. Our archives would then be complete and our League historian would be happy.

2017 Webmaster Award

The time is now. The deadline for submissions for the Astronomical League's Webmaster Award is April 1, 2017 (no fooling).

The Webmaster Award recognizes the effort of those individuals who produce the vibrant, informative websites that are so essential to the growth and vitality of astronomy clubs. Each year the League presents the Webmaster Award to the webmaster of the best club website. A website is an important asset for any astronomy club, and this award acknowledges the winning webmaster's outstanding job of website design and administration.

Websites are judges on:

- Technical and visual design and organization
- Content, including club activities, club calendar, educational content, and links
- Outreach
- Administration and timeliness of content

Club presidents are asked to send webmaster nominations and the club's website address, no later than April 1, 2017, to *webmasteraward@astroleague.org* or to Mike Rao, Astronomical League Webmaster Award Administrator, 2328 Naomi Street, Houston, TX 77054.

2016 Mabel Sterns Newsletter Editor Award

Congratulations to this year's 2016 Mabel Sterns Newsletter Editor Award winner, **John Helper** of the **Chester County Astronomical Society**. His newsletter, *Observations*, was chosen from a field of nominations for this honor.

Second place was awarded to **Carl Wenning**, editor of *The Observer* of the **Twin City Amateur Astronomers**, and third place was awarded to **Eric Fischer**, editor of *The Guide Star* of the **Amateur Astronomers Association of Pittsburgh**.

John Helper

Carl Wenning

Eric Fischer

2016 Horkheimer/O'Meara Journalism Award

This year's award went to **Clay Parenti** of the Houston Astronomical Society, an eighth grade student at Westchester Academy for International Studies in Houston, Texas, for his writing on Kepler's laws. Second place goes to **Ephraim Craddock** of Baton Rouge Astronomical Society, a fifth grade student at Galvez Primary School in Prairieville, Louisiana, who wrote on "Examining the Mystery of Tabby's Star."

Finding the Cosmic Order

The Story of Kepler's Laws of Motion

By Clay Parenti

Kepler's laws of motion marked a major turning point in the history of astronomy and science. It threw out the old systems of epicycles and orbs and replaced it with a system based on physics and observation that holds true to this day. It was the beginning of a scientific revolution in astronomy that led to Newton and the rest of modern science, astronomy and physics.

The story of Kepler's laws of motion begins with Johannes Kepler, a former seminary student and at the time a teacher in Austria. While he was teaching, he had an epiphany. He wondered why there were only six planets and five platonic solids. Could they be connected? Could the platonic solids have something to say about the distances between the planets? His theory was that the spacing of the platonic solids predicted the spacing of the planets. He set out to find evidence to prove his theory, which he called the Mysterium Cosmographicum or "The Cosmic Mystery". His theory somewhat agreed with the rudimentary astronomical observations of the time and disagreed with others. He badly needed good observations. At the time, the best astronomical observations were in the hands of an observational genius named Tycho Brahae, the Imperial Mathematician for the Holy Roman Empire. Tycho Brahae was a Danish astronomer who was renowned for his exceptionally accurate naked eye observations of the night sky. Kepler visited Tycho at his observatory in Prague and decided to work for him to see if his data confirmed his Mysterium Cosmographicum. Tycho, not wanting to be eclipsed by a potential rival, was reluctant to give all of his observations up to Kepler. With so little data, it was hard for Kepler to progress on his theory and the projects that Tycho gave him to work on. After Tycho died, Kepler inherited Tycho's observations and his position as Imperial Mathematician. Now, with Tycho's observations, he could finally prove his theory.

After looking at Tycho's data on Mars, Kepler found that the Mysterium Cosmographicum was wrong. He tried to explain the movements of the planets, but circular motion didn't conform with observations. Desperately, he tried motion in an ellipse. It fit in perfectly with the data. Using this discovery, he formulated his first law of planetary motion: A planet travels in an ellipse with the Sun at one focus. Next, he found his second law of planetary motion when he compared the motions of planets when in different parts of the sky relative to the Sun. He found that a line joining the planet and Sun sweeps out equal areas in equal times, so that planets move faster when they are closer to the Sun and slower when they are further away. Kepler suggested a force akin to magnetism could be responsible for these motions.

These laws of motion were among the first non-mystical explanations of the movements of heavenly bodies. Kepler's laws are obeyed by all bodies in the universe, and have stood up to scrutiny for centuries.

Examining the Mystery of Tabby's Star

By Ephraim Craddock

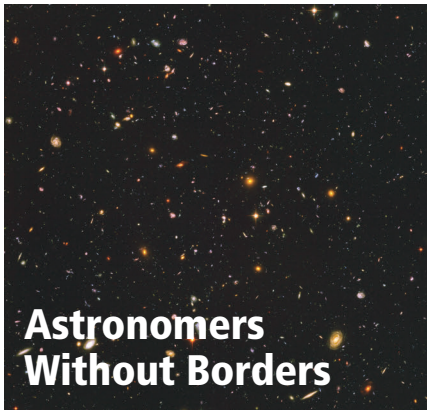
When people think about mysteries they usually think about television detective shows or about books about people like Sherlock Holmes. However, some of the greatest detectives in the world are scientists. These scientists devote these lives to solving the mysteries of the universe. The method they use solve these mysteries is the greatest sleuthing tool of all time, the scientific method! Using the scientific method they make observations, come up with hypothesis to explain what they observe, and test whether or not their hypothesis is correct. Using the scientific method helped Le Verrier use the irregularities in the orbit or Uranus to discover Neptune and it helped Semmelweiss use knowledge of how disease spread to convince doctors to wash their hands. One of science's greatest cases, still unsolved, is why a star 1480 light years from Earth keeps getting dimmer in ways that cannot easily be explained.

Star KIC 8462852, also known as Tabby's Star, is located in the constellation Cygnus. No one thought anything was unusual about this star until scientists looked at information from the Kepler Space Telescope. They were looking for dimming of the star's light to determine if planets orbited the star. A planet more massive than Jupiter would cause a star's light to dim about one percent. However, this star, known as Tabby's Star, dims as much as 20 percent. But why? But the mystery of Tabby's Star does not stop there. Brad Schaefer, an astronomer, looked at historical data on Tabby's Star and found that not only does the star dim up to 20 percent intermittently, but its overall brightness has dimmed about 20 percent over the last 100 years. Astronomers now have an interesting mystery to solve.

Scientists jumped into action, using the scientific method to try to determine why Tabby's Star dims in such unusual ways. A group of scientists led by Tabetha Boyajian, for whom Tabby's Star is named, first examined data from the Kepler Space Telescope and found that there were no errors in the data itself. Boyajian and her team hypothesized that the 20 percent dimming was caused by a large group of comets or a large cloud of space dust. But even this did not explain all the data, because scientists cannot find the sort of infrared energy around Tabby's Star that they would expect to see if there was a large cloud of space dust and comets orbiting it.

Tabby's Star and its fluctuating brightness gained worldwide popularity when Astronomer Jason Wright hypothesized that the dimming might be caused by a Dyson Sphere, an alien object. A Dyson Sphere is a theoretical technology that could be used to collect the energy from a star. However, SETI, the search for extraterrestrial intelligence, a group that searches for radio transmissions and other evidence of extraterrestrial intelligence have found no signals from the area of the sky around Tabby's Star. This means that Tabby's Star odd dimming is probably not caused by an alien object.

So what should scientific sleuths do? For now, accept that the best theory is that the dimming is caused by something natural, like comets or space dust, and wait for new and better data. Le Verrier theorized the planet Neptune, but did not have a telescope powerful and accurate enough to see his new planet, so he sent his data to other scientists who had telescopes powerful enough to observe Neptune. Scientists today will have to wait for better tools, just like Le Verrier. The good news is that new data about Tabby's Star should be available soon. The James Webb Space Telescope will be launched into space in 2018. This telescope will have infrared sensing capabilities that will be able to tell us if Tabby's Star's dimming is caused by a cloud of space dust or something solid. This new space telescope might even be able to determine the shape of the object causing the dimming. When scientists final solve the mystery of Tabby's Star what they find might fit into what we already know, or it might teach us something new about the universe. Either way, the light from Tabby's Star takes 1480 years to get to Earth, so no matter what scientists find, either natural or artificial, happened a long time ago in a galaxy far, far away.



Astronomy is universal. Amateur astronomers come from all walks of life, as do the people who line up at outreach events to see the Moon or Saturn. And that's true for every country and culture as well. Pick a spot on the globe at random, travel there, and you'll find people who love to gaze at the night sky, learn about celestial objects, and ponder the mysteries they present.

Astronomers Without Borders brings the world of astronomy to everyone, and there are plenty of surprises when you look abroad. The amateur astronomy community in Iran is among the world's most active. South Asia–India, Pakistan, Nepal, and Sri Lanka–has a lot going on. Brazil's clubs span the huge country. Ethiopia is building research observatories and teaching astronomy at all levels. Despite troubles and even danger, amateurs in Afghanistan, Iraq, and Libya are still active. The hobby may be different where equipment is hard to get or too costly but the stars and planets are still there to enjoy. Ironically, in many undeveloped countries there is even more dark sky than we enjoy in industrialized nations where big telescopes are common. North Americans and Europeans who travel to Africa to see the animals end up enamored as much by the night sky.

The most common activity for amateur astronomers worldwide, though, doesn't require the darkest skies (though light pollution is still a concern everywhere). Astronomers love sharing their passion with others, and public outreach and education programs are usually in the cities where the people are. Member reports shared on the Astronomers Without Borders website are full of familiar scenes of smiling children and amazed adults. The reaction to exploring the Universe for the first time is the same whether it's in New York, Nigeria, or Nicaragua; Boston, Bolivia, or Beijing; Minneapolis, Mexico, or Malaysia.

AWB
Astronomers Without Borders

Joining Astronomers Without Borders means discovering the world of astronomy in all its forms. Community programs connect us to observe together. AstroArts shows the many ways astronomy inspires us. Resource-sharing programs are an opportunity to help amateurs and students around the world enjoy our shared passion. Free membership is available so that everyone can belong to the world's largest astronomy community. And each April there is **Global Astronomy Month**, the world's biggest annual astronomy event.

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Observers in Oman

A view of the Sun in Romania

Collecting Meteorites/*from page 19*

are the direct result of meteorites hitting the Earth. Meteorite collectors typically have a side collection of these specimens. Tektites are a natural glass formed when terrestrial debris is ejected into the atmosphere during an impact. The debris cools into droplets that harden into a black, shiny glass. The most common tektites are called indochinites and occur in Southeast Asia. They are only about 610,000 years old. Moldavites are green translucent tektites found only in Czechoslovakia. Their source has been identified as the Nördlinger Ries impact crater in Germany. Shatter cones are rare geological features that only form in the bedrock beneath meteorite impact craters. They are evidence that the rock has been subjected to shock with very high pressures from an extraterrestrial impact. An impactite is a glassy object produced by the fusion of rock and meteorite fragments by the heat developed from the impact of a meteorite on the Earth's surface. The Ries crater contains a substantial amount of impactite.

When first starting a collection, I would begin with the most reasonably priced, commonly available meteorites. These include stones such as Allende CV3, Millbillillie (eucrite), Tatahouine (diogenite), and numerous NWA meteorites (howardite); irons such as Campo del Cielo (IA), Sikhote-Alin (IIB), Canyon Diablo (IA), Odessa (IA), Gibeon (IVA), and Nantan (IIICD); and stony-irons, such as Esquel, Imilac, Brenham, and Vaca Muerta.

The addition of authentic meteorites to an amateur astronomer's arsenal of equipment would be of great benefit to their understanding of the universe. Cloudy nights could be spent contemplating, curating, and learning about the wonders of these alien extraterrestrials we call meteorites. Astronomical League members now have the fundamental knowledge to begin their own collection of meteorites—so let's get started!

Radio Astronomy Observing Program

Tired of observing with just your eyes? How about looking (or listening) to the skies with an entirely different view not possible with human senses? The Radio Astronomy Observing Program has levels for observing with radio frequencies for the beginner, the initiated, and those who are exploring their capabilities in depth. Explore different methods with simple or complex equipment—it's your choice. Ham operators find this a unique way to further enjoy their hobby. Design your own equipment, buy something off the shelf, or adapt designs from others. Any way you choose, radio astronomy can be an adventure to meteors, planets, the Sun, space weather, or even our galaxy and beyond in the radio spectrum.

Editor's Note: Congratulations to all these outstanding astronomical observers! All awards, except the Herschel 400, require current Astronomical League membership for eligibility. If you have questions about an award, please contact the corresponding Observing Program chair. Their contact information can be found on the Observing Program website at *www.astroleague.org/observing*. If further assistance is required please contact either of the national Observing Program coordinators.

Observing Awards

Advanced Binocular Double Star Observing Program

No. 15, Terry N. Trees, Amateur Astronomers Association of Pittsburgh

Asterism Observing Program

No. 35, Kevin Nasal, Neville Public Museum Astronomical Society; No. 36, Kathy Machin, Astronomical Society of Kansas City

Asteroid Observing Program

No. 46, Henry G. Stratmann, Regular, Ozarks Amateur Astronomy Club

Binocular Double Star Observing Program

No. 110, Steve Coltrin, Rio Rancho Astronomical Society; No. 111, Andreea Boeck, Omaha Astronomical Society; No. 112, Jnani Cevvel, Member-at-Large; No. 113, Don Knabb, Chester County Astronomical Society

Binocular Messier Observing Program

No. 1082, David Furry, Southern Colorado Astronomical Society; No. 1083, Jeff Oaster, Delaware Valley Amateur Astronomers; No. 1084, Steve King, Astronomical Society of Kansas City; No. 1085, Denise Moser, Astronomical Society of Kansas City; No. 1086, Tim Livingston, Oklahoma City Astronomy Club; No. 1087, Katie Raney, Austin Astronomical Society; No. 1088, Don Selle, Houston Astronomical Society; No. 1089, DeWayne Carver, Member-at-Large; No. 1090, Steve Coltrin, Rio Rancho Astronomical Society; No. 1091, Lisa Wentzel, Twin City Amateur Astronomers; No. 1092, Jeff Hiscock, Member-at-Large; No. 1093, Alice Stanley, Member-at-Large; No. 1094, Greg Moore, Member-at-Large

Binocular Variable Star Observing Program

No. 12, Jim Ketchum, Astronomical Society of Kansas City; No. 13, Kevin McKeown, Albuquerque Astronomical Society

Carbon Star Observing Program

No. 71, Mark McCarthy, The Astronomy Connection; No. 72, Raymond B. Howard, Eastbay Astronomical Society; No. 73, Christen K. Slotten, Olympic Astronomical Society

Comet Observing Program

No. 34, Peter K. Detterline, Gold, Member-at-Large; No. 87, Vincent Michael Bournique, Silver, Lifetime Member

Constellation Hunter Observing Program (Northern Skies)

No. 176, Fred Schumacher, Member-at-Large; No. 177, Steven Powell, Houston Astronomical Society; No. 178, Michel Dellepere, Youth Member-at-Large

Constellation Hunter Observing Program (Southern Skies)

No. 8, Steven Powell, Houston Astronomical Society

Double Star Observing Program

No. 588, James Granahan, Northern Virginia Astronomy Club; No. 589, Edward Wiley, Austin Astronomical Society; No. 590, Rick Olson, Rose City Astronomers

Galileo Observing Program

No. 38, Bruce P. Bookout, Colorado Springs Astronomical Society

Globular Cluster Observing Program

No. 287-I, David M. Douglass, East Valley Astronomy Club; No. 288-V, Bob Gamache, Delaware Valley Amateur Astronomers; No. 289-V, David W. Hudgins, Astronomical Society of Kansas City; No. 290-V, Philip Smith, Member-at-Large; No. 291-V, Fred D. Hanson, Member-at-Large; No. 292-V, Kevin Mayock, Rose City Astronomers; No. 293-V, Mike Blase, Tulare Astronomical Association; No. 294-V, John Laning, Member-at-Large; No. 295-V, Steve Goldberg, Houston Astronomical Society

Herschel 400 Observing Program

No. 562, Valorie Whalen, Atlanta Astronomy Club; No. 563, Lauren Gonzalez, Austin Astronomical Society; No. 564, Barbara Biever, Rancho Bernardo/Murrieta Astronomical Society; No. 565, Steve Goldberg, Houston Astronomical Society; No. 566, Kevin Nasal, Neville Public Museum Astronomical Society

Hydrogen Alpha Solar Observing Program

No. 32, Al Lamperti, Delaware Valley Amateur Astronomers; No. 33, Alan Rutter, Flint River Astronomy Club

Lunar Observing Program

No. 959, Nathaniel S. Prentice, Delaware Valley Amateur Astronomers; No. 960, Ron Kane, Tri-Valley Stargazers Astronomy Club; No. 961, Danny Lineberger, Greensboro Astronomy Club; No. 962, Marilyn Perry, Member-at-Large; No. 963, Michel Dellepere, Youth Member-at-Large; No. 964, Russell F. Pinizzotto, Member-at-Large; No. 965, Kim Balliett, Richland Astronomical Society; No. 966, Ron Balliett, Richland Astronomical Society; No. 967, Carter Boe, Member-at-Large; No. 968, Linda Claire Freeman, Umpqua Astronomers

Lunar II Observing Program

No. 74, Antone Gregory, Minnesota Astronomical Society; No. 75, Stephen Tzikas, Northern Virginia Astronomy Club; No. 76, Fred Schumacher, Member-at-Large; No. 77, Walter Jablonski, New Hampshire Astronomical Society

Master Observer (Progression)

Observer Award: Vincent Michael Bournique, Lifetime Member; Kevin Carr, Minnesota Astronomical Society; Nora Jean Chetnik, Member-at-Large; Aaron Clevenson, North Houston Astronomy Club; Vincent S. Foster, Member-at-Large; Lauren Gonzales, Austin Astronomical Society; Jeff Hoffmeister, Olympic Astronomical Society; Michael A. Hotka, Longmont Astronomical Society; Jim Ketchum, Astronomical Society of Kansas City; Scott G. Kranz, Astronomical Society of Kansas City; Anthony J. Kroes, Neville Public Museum Astronomical Society; Marie Lott, Atlanta Astronomy Club; W. Maynard Pittendreigh, Member-at-Large; James Pryal, Seattle Astronomical Society; George J. Robinson, Member-at-Large; Rodney R. Rynearson, Saint Louis Astronomical Society; Philip Sacco, Flint River Astronomy Club; Rebecca Saflarki, City Lights Astronomical Society for Students; Bill Sanders, Central Arkansas Astronomical Society; Sandra J. Shaw, Denver Astronomical Society; Mark Simonson, Everett Astronomical Society; John T. Varn, Cedar Amateur Astronomers; Bernard Venasse, Member-at-Large; Rhonda Weygandt, Boise Astronomical Society; Sue Wheatley, North Houston Astronomy Club; Brad Young, Astronomy Club of Tulsa

Advanced Observer Award: Vincent Michael Bournique, Lifetime Member; Kevin Carr, Minnesota Astronomical Society; Aaron Clevenson, North Houston Astronomy Club; Vincent S. Foster, Member-at-Large; Michael A. Hotka, Longmont Astronomical Society; Jim Ketchum, Astronomical Society of Kansas City; Scott G. Kranz, Astronomical Society of Kansas City; Anthony J. Kroes, Neville Public Museum Astronomical Society; W. Maynard Pittendreigh, Member-at-Large; George J. Robinson, Member-at-Large; Mark Simonson, Everett Astronomical Society; Sue Wheatley, North Houston Astronomy Club; Brad Young, Astronomy Club of Tulsa

Master Observer Award: No. 180, Ken Pryor, Oklahoma City Astronomy Club; No. 181, Grant Mills, Member-at-Large; No. 182, Jeffrey Corder, Ancient City Astronomy Club; No. 183, Margaret McCrea, Rose City Astronomers; No. 184, Marie Lott, Atlanta Astronomy Club; No. 185, Lauren Gonzalez, Austin Astronomical Society; No. 186, David Whalen, Atlanta Astronomy Club; No. 187, Valorie Whalen, Atlanta Astronomy Club

Master Observer Award—Silver: Aaron Clevenson, North Houston Astronomy Club; Michael A. Hotka, Longmont Astronomical Society; Brad Young, Astronomy Club of Tulsa

Master Observer Award—Gold: Aaron Clevenson, North Houston Astronomy Club; Michael A. Hotka, Longmont Astronomical Society; Brad Young, Astronomy Club of Tulsa

Master Observer Award—Platinum: Brad Young, Astronomy Club of Tulsa

Messier Observing Program

No. 2561, Hugh Stevens, Honorary, Texas Astronomical Society of Dallas; No. 2597, Larry Farrington, Honorary, Mt. Shasta Stargazers; No. 2727, Zack Stockbridge, Honorary, Member-at-Large; No. 2732, Antone G. Gregory, Honorary, Minnesota Astronomical Society; No. 2733, Michael Blase, Honorary, Tulare Astronomical Association; No. 2739, Terry Mealy, Regular, Amateur Astronomers Association of Pittsburgh; No. 2740, Juan Velasquez, Honorary, Denver Astronomical Society; No. 2741, Kristin Hendershot, Honorary, Shenandoah Astronomical Society; No. 2742, Dee Friesen, Honorary, Albuquerque Astronomical Society; No. 2743, Janet Rush, Regular, Delaware Valley Amateur Astronomers; No. 2744, Tristan Schwartz, Honorary, Colorado Springs Astronomical Society; No. 2745, Nick Monkman, Honorary, Spokane Astronomical Society; No. 2746, Steve Bardus, Honorary, Member-at-Large; No. 2747, Donnie Bunch, Honorary, Hill Country Astronomers

Meteor Observing Program

No. 151, Grace Aikman, 18 hours, Member-at-Large; No. 163, Jean Napp, 30 hours, Iowa County Astronomers; No. 173, Vincent Michael Bournique, 12 hours, Lifetime Member; No. 180, Ayaka Yuko Komata, 6 hours, Smoky Mountain Astronomical Society; No. 181, Robert Clark, 6 hours, Westminster Astronomical Society; No. 182, Vincent Giovannone, 6 hours, Member-at-Large

NEO Observing Program

No. 9, Rick Owens, Intermediate, Astronomical Society of Kansas City

Open Cluster Observing Program

No. 77 Advanced, David Douglass, East Valley Astronomy Club

Outreach Observing Award

No. 113-S, Jim Dixon, Central Arkansas Astronomical Society; No. 398-M, Alex McConahay, Pomona Valley Amateur Astronomers; No. 440-S, Jim Ketchum, Astronomical Society of Kansas City; No. 442-M, Gary Bell, Northwest Suburban Astronomers; No. 483-S, Sara Sheidler, Popular Astronomy Club; No. 637-M, David Whalen, Atlanta Astronomy Club; No. 738-O, James Bruce McBath, Central Arkansas Astronomical Society; No. 739-O, Carol Smith, Boise Astronomical Society; No. 740-O, Raymond B. Howard, Eastbay Astronomical Society; No. 741-O, Bridget Langdale, Mason Star Gazers; No. 742-S, David Tondreau, Denver Astronomical Society; No. 743-O, Terry Dufek, Popular Astronomy Club; No. 744-O, Stephen Caldwell, Central Arkansas Astronomical Society; No. 745-O, Amelia Goldberg, Houston Astronomical Society; No. 746-O, David Haire, Flint River Astronomy Club; No. 747-O, Mel Schroeder, Popular Astronomy Club; No. 748-S, Brendon O'Keeffe, Flint River Astronomy Club; No. 749-O, Bob White, San Bernardino Valley Amateur Astronomers; No. 750-O, Chris Clarke, San Bernardino Valley Amateur Astronomers; No. 751-O, Fidel Hernandez, San Bernardino Valley Amateur Astronomers; No. 752-O, Nick Broman, San Bernardino Valley Amateur Astronomers; No. 753-O, Tom Larson, San Bernardino Valley Amateur Astronomers; No. 754-O, Robert Trebilcock, Delaware Astronomical Society; No. 755-O, Paul Lennous, Member-at-Large; No. 756-O, Nathaniel S. Prentice, Delaware Valley Amateur Astronomers No. 757-O, Mike Ombrello, Popular Astronomy Club; No. 758-O, Peter Soble, Popular Astronomy Club; No. 0759-O, Steve

TITLE PHOTOGRAPH: M64, THE BLACK EYE GALAXY; NASA AND THE HUBBLE HERITAGE TEAM (AURA/STSCI)

Goldberg, Houston Astronomical Society; No. 760-O, Joe Khalaf, Houston Astronomical Society; No. 761-S, Bob Scott, Island County Astronomical Society; 762-O, Fred Schumaker, Member-at-Large; 763-O, Steven Hollander, Flint River Astronomy Club; No. 764-O, Margaret McCrea, Rose City Astronomers

Planetary Nebula Observing Program

No. 4, W. Maynard Pittendreigh, Southern Planetary Nebula Certificate, Lifetime Member; No. 30, Tom Gazzillo, Chesmont Astronomical Society, Basic, Manual; No. 67 Paul Harrington, Advanced, Manual, Member-at-Large

Planetary Transit (Mercury) Special Observing Award

Eddie Agha, Astronomical Society of Eastern Missouri; Stephen Andrews, Kern Astronomical Society; Diane Bagley, Boise Astronomical Society; Jim Barbasso, North Houston Astronomy Club; Steve Bardus, Member-at-Large; Wayland Bauer, The Popular Astronomy Club; Kristin Berry, Astronomical Society of Eastern Missouri; Tom Berry, Astronomical Society of Eastern Missouri; Robert Beuerlein, Back Bay Amateur Astronomers; Bill Biermann, St. Louis Astronomical Society; Steve Boerner, Astronomical Society of Eastern Missouri; Bret Boller, Prairie Astronomy Club; Ken Boquist, The Popular Astronomy Club; Tom Campbell, Brazos Valley Astronomy Club; Aaron Clevenson, North Houston Astronomy Club; Jeff Creed, Boise Astronomical Society; Mark Croom, Member-at-Large; Louis Dorland, Omaha Astronomical Society; Amy Drew, Neville Public Museum Astronomical Society; Jack Fitzmier, Atlanta Astronomy Club; Thomas Flatley, Back Bay Amateur Astronomers; Bill Geertsen, Southwest Florida Astronomical Society; Dino Giangregorio, Back Bay Amateur Astronomers; Mary Giangregorio, Back Bay Amateur Astronomers; Jeff Goldstein, Back Bay Amateur Astronomers; Roy Gustafson, The Popular Astronomy Club; Irwin Horowitz, Boise Astronomical Society; Michael Hotka, Longmont Astronomical Society; Charles Jagow, Back Bay Amateur Astronomers; Mark Job, Minnesota Astronomical Society; Yu-Hang Kuo, Seattle Astronomical Society; Leigh Anne Lagoe, Back Bay Amateur Astronomers; Curt Lambert, Back Bay Amateur Astronomers; Carmen Lawrence, Back Bay Amateur Astronomers; Jay Levy, Houston Astronomical Society; Benito Loyola, Back Bay Amateur Astronomers; Grant Martin, Astronomical Society of Eastern Missouri; Annette McLean, Back Bay Amateur Astronomers; William McLean, Back Bay Amateur Astronomers; Timothy Myer, Astronomical Society of Southeast Texas; Mike Neal, Echo Ridge Astronomical Society; Andy Nielsen, Island County Astronomical Society; Ruth Nielsen, Island County Astronomical Society; David Novotny, Rose City Astronomers; Russell Pinizzotto, Member-at-Large; Maynard Pittendreigh, Member-at-Large; Jonathan Poppele, Minnesota Astronomical Society; Mike Pusatera, Astronomical Society of Eastern Missouri; Theo Ramakers, Atlanta Astronomy Club; George Reynolds, Back Bay Amateur Astronomers; Bill Sanders, Central Arkansas Astronomical Society; Patrick Scheible, Seattle Astronomical Society; Alan Scheidler, The Popular Astronomy Club; Andrew Shapton, Member-at-Large; Fred Shumacher, Member-at-Large; Mark Simonson, Everett Astronomical Society; Carol Smith, Boise Astronomical Society; Melvin Spruill, Jr., Back Bay Amateur Astronomers; Michael Stauffer, Boise Astronomical Society; Carol Stewart, Southwest Florida Astronomical Society; Zack Stockbridge, Member-at-Large; Jim Tallman, Back Bay Amateur Astronomers; Bird Taylor, Back Bay Amateur Astronomers; Ben Toman, Baton Rouge Astronomical Society; Robert Trebilcock, Delaware Valley Amateur Astronomers; Marcus Tuepker, Denver Astronomical Society; Miles Tuepker, Denver Astronomical Society; Stephen Tzikas, Northern Virginia Astronomy Club; Alex Vrenios, Lifetime Member; Seth Watts, Member-at-Large; Michael Webster, Back Bay Amateur Astronomers; Christian Weis, Tucson Amateur Astronomy Association; Glenn Wolford, Member-at-Large; Anna Woolridge, Atlanta Astronomy Club; Mark Woolridge, Atlanta Astronomy Club; Adam Yore, Member-at-Large; Brad Young, Astronomy Club of Tulsa; Jim Zappa, Member-at-Large

Continued on next page

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The following is a listing of the advertising rates for the *Reflector*. If you are interested in promoting your products, consider placing an ad with us. We offer a highly targeted market with a circulation of 16,000 astronomers.

Rates for the inside front cover, inside back cover, and back cover are negotiable.

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To submit advertisements or for further information, please contact: Carla Johns, Advertising Representative, at c.johns@icloud.com or 1-970-567-8878.

Coming Events

To have your star party or event listed, please send the details, including dates, sponsors and website, to *astrowagon@verizon.net*. Confirm dates and locations with event organizers. —John Wagoner

January 25–29
Orange Blossom Special XXII International Star Party
Withlacoochee River Park, Dade City, Florida
www.stpeteastronomyclub.org/obs.php

January 27–28
Furnace Creek Resort/LVAS Star Party
Death Valley National Park, California
www.furnacecreekresort.com

February 18
Regional Meeting of Amateur Astronomers 2017
Catawba Science Center, Hickory, North Carolina
www.catawbasky.org

February 20–26
Winter Star Party
West Summerland Key, Florida
scas.org/winter-star-party

March 3-4
Greensboro Astronomy Club and the Cline Observatory
Guilford Technical Community College
Jamestown, North Carolina
observatory.gtcc.edu/tristar

April 8–9
Northeast Astronomy Forum
Suffern, New York
www.rocklandastronomy.com/neaf.html

April 21–22
North Carolina Statewide Star Party
35+ public skywatching sessions from the North Carolina mountains to the coast
www.ncsciencefestival.org/starparty

April 22–29
The 2017 OzSky Star Safari
(aka Deepest South Texas Star Safari)
Coonabarabran, New South Wales, Australia
www.ozsky.org

April 26–29
Mid-South Star Gaze and Astronomy Conference
French Camp, Mississippi
www.rainwaterobservatory.org/rainwater

June 21–25
Rocky Mountain Star Stare 2017
Gardner, Colorado
www.rmss.org

Observing Awards/*from page 29*

Sketching Observing Award
No. 9, Al Lamperti, Delaware Valley Amateur Astronomers; No. 10, Stephen McGaughey, Haleakala Amateur Astronomers; No. 11, John R. "Sean" Sayers, Member-at-Large

Solar System Observing Program
No. 96, David Whalen, Atlanta Astronomy Club; No. 97, Michel Dellepere, Member-at-Large; No. 98, Lauren Gonzalez, Austin Astronomical Society; No. 99, Dan Posey, Hill Country Astronomers; No. 100, Paul Lennous, Member-at-Large; No. 101, Valorie Whalen, Atlanta Astronomy Club; No. 102, Alex McConahay, Pomona Valley Amateur Astronomers; No. 103, Barbara Biever, Rancho Bernardo/Murrieta Astronomical Society; No. 104, Robert Togni, Central Arkansas Astronomical Society

Southern Skies Binocular Observing Program
No. 95, Al Hamrick, Raleigh Astronomy Club; No. 96, Rakhal Kincaid, Haleakala Amateur Astronomers

Southern Skies Telescopic Observing Program
No. 52, Al Hamrick, Raleigh Astronomy Club

Two in the View Observing Program
No. 15, Vincent Michael Bournique, Lifetime Member; No. 16, Cliff Mygatt, Olympic Astronomical Society; No. 17, Dan Crowson, Astronomical Society of Eastern Missouri; No. 18, Kathy Machin, Astronomical Society of Kansas City; No. 19, Dick Francini, Neville Public Museum Astronomical Society; No. 20, Kevin Mayock, Rose City Astronomers

Universe Sampler Observing Program
No.126, Valorie Whalen, Naked-Eye, Atlanta Astronomy Club; No. 127, Mike C. Neal, Telescope, Echo Ridge Astronomical Society; No. 128, Mike Blase, Naked-Eye and Telescope, Tulare Astronomical Society

Urban Observing Program
No.171, Paul Harrington, Member-at-Large; No. 172, Michael Blase, Tulare Astronomical Association; No. 173, David Whalen, Atlanta Astronomy Club; No. 174, Valorie Whalen, Atlanta Astronomy Club; No. 175, Paul Lennous, Member-at-Large; No. 176, Henry Stratmann, Ozarks Amateur Astronomers Club; No. 177, Ed Fraini, Houston Astronomical Society

Reflections/*from page 7*

* When the link to the digital issue is sent by email, there will be instructions on how to "opt out" for digital, paper, neither, or both.
* Some of the advantages of the digital edition are: its arrival one or two weeks before the printed version; an expanded version (in the near future) with additional articles, advertisements, images, and editorials; the ability to zoom in (or out) on any page, which can be used to change the size of the type or examine an image in greater detail; and it helps reduce the cost of publication to the League.

Ron Kramer, Editor

International Dark-Sky Association

From page 6

13. Great Basin, Nevada, 2016. This park is located approximately 290 miles north of Las Vegas and is notable for its groves of ancient bristlecone pines, the oldest known trees.

These magnificent parks with their extraordinary dark skies are just a smattering of the jewels in the National Park Service's collection. Just think of the innumerable hours of enjoyment you can have by visiting any one of the NPS parks, many of which also have incredibly dark skies similar to those who have received a Dark Sky Park designation. There is much to see in our national parks, day and night.

To find out more about IDA's Dark Sky Program, check out its International Dark Sky Places website, *darksky.org/idsp*.

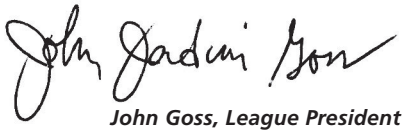
Tim Hunter, Co-founder, IDA
Phone: 520-293-3198; Fax: 520-293-3192
Email: *ida@darksky.org*; *www.darksky.org*

Field of View/*from page 4*

printed version of this colorful and informative periodical. It is truly the face of the Astronomical League, and a key voice in national amateur astronomy.

Public outreach activities, astronomy gatherings of all types, collaborations with NASA, interactions with other organizations of the astronomical community, and light pollution awareness are all either enhanced or made possible by the Astronomical League's efforts.

In short, no other respected national organization exists that strives to attain the goals of the Astronomical League: to promote the science of astronomy by fostering astronomical education, by providing incentives for astronomical observation and research, and by assisting communication between amateur astronomical societies.



John Goss, League President

The Sky This Week

To find out what's happening in the sky the coming week, take a look at "The Sky This Week" on *Astroleague.org*. Produced by our own Vern Raben, this weekly five-minute program covers the Moon, visible planets, comets, and interesting stellar features. Why not tune in this week?

Astronomical League Membership-at-Large Program

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

• Full voting privileges at AL meetings.• A subscription to the *Reflector*.
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• Optional subscriptions at discounted rates to the following publications:
Astronomy magazine $34.00; 2 years $60 • *Sky & Telescope* magazine $32.95
RASC *Observer's Handbook* $27.00 • *StarDate* $19.50
(Foreign rates are higher; see website)
• Free Astronomical League Observing guide with membership.

To join the Astronomical League as a Member-at-Large, send a check for $40.00, $50.00 foreign, made payable to the Astronomical League, to:
Astronomical League National Office, 9201 Ward Parkway, #100, Kansas City, MO 64114
Phone: 816-333-7759; Email: *leagueoffice@astroleague.org*
Or join online at: WWW.ASTROLEAGUE.ORG

TITLE PHOTOGRAPH: "CONE NEBULA"; CREDIT: NASA, H. FORD (JHU), G. ILLINGWORTH (UCSC/LO), M. CLAMPIN (STSCI), THE ACS SCIENCE TEAM, AND ESA.

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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**.

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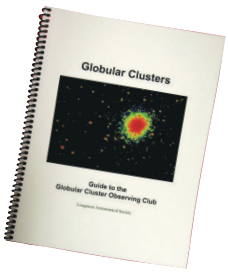

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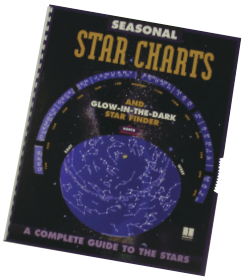

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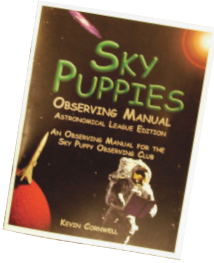

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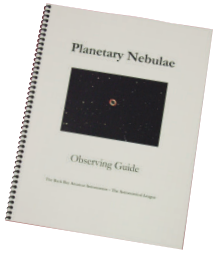

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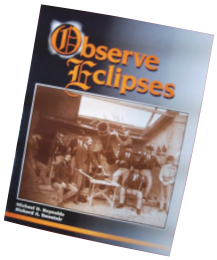

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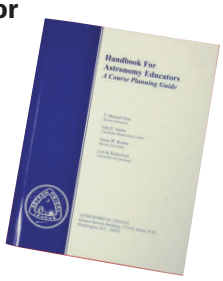

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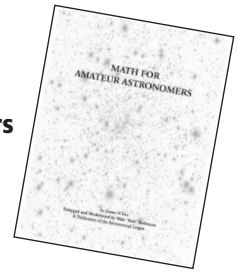

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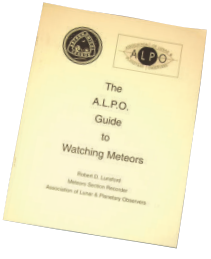

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