Reflector

Published by the Astronomical League Vol. 70, No. 4 September 2018

ALCon 2018, Minneapolis

Observing Awards for Aspiring Youth

White Snow on the Seven Dwarves

Departing Message from the League President

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

Contents

4 Field of View

5 Reflections

6 International Dark-Sky Association
LEDs and Skyglow

7 All Things Astronomical

9 Deep-Sky Objects
The Eagle's Best Nebula

10 Wanderers in the Neighborhood
Making a Moon

13 White Snow on the Seven Dwarves

16 ALCon 2016 in Review
Minnesota Astronomical Society's Great Party!

20 From Around the League
Young Astronomer Annual Awards

24 Full STEAM Ahead
The Art in ATM

27 Gallery

28 Observing Awards

30 Coming Events

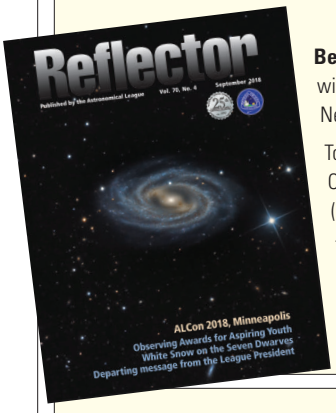
Page 4

Page 9

Page 16

Page 16

Page 20



Bernard Miller (East Valley Astronomy Club) took this fantastic image of M109 with a PlaneWave 17-inch CDK and an Apogee CG16M CCD camera from Dark Sky New Mexico, Animas, New Mexico.

To our contributors: The copy and photo deadline for the December 2018 issue is October 1. Please send your stories and photos to our editor, **John Martin** (*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

Vol. 70, No. 4 • ISSN: 0034-2963 • September 2018

A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION

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

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

Reflector

QUARTERLY PUBLICATION OF THE ASTRONOMICAL LEAGUE

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

Digital subscriptions:
All countries, possessions, and territories: $10.00 per year

***Reflector* and Club Roster Deadlines**

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

Field of View

From the office of your president

The State of the Astronomical League

Personal time under the star-filled dome; monthly gatherings, observing sessions, and public observing; books, magazines, and star charts; workshops, conventions, and star parties; and, of course, binoculars, telescopes, and a wide assortment of gear: all are facets of our amazing avocation.

None of them are in short supply either—except, perhaps, the time that members spend gazing skyward. Nevertheless, doesn't this mean that amateur astronomy is doing well?

Because of the League's generalized approach at encouraging people to enjoy the celestial realm, it has been quietly voiced, "As the Astronomical League goes, so goes amateur astronomy." With well over 17,000 members spread across the country, its health could be considered to be a bellwether of organized amateur astronomy as a whole.

A Non-Equation of State

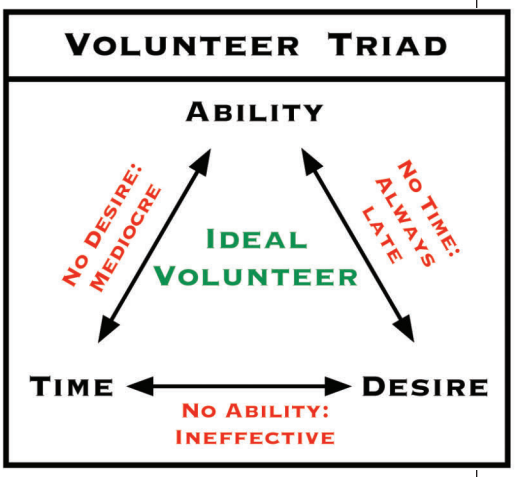
Everything the League does can be condensed into four interrelated elements, which can be used to gain a picture of the state of our organization. These factors can be expressed by a strange-looking and strictly qualitative entanglement. It is not a profit/loss summary, but more of an indication of organizational effectiveness.

$$(R + V) - E \rightarrow B$$

The first factor, **R**, considers the number of people who belong to the Astronomical League. Currently, the League's membership level is near its historic high, and there is no reason to think that it can't go higher—but only if more amateur astronomers in more clubs are made aware of the many benefits and low cost of belonging to this respected national organization. Financially, all that is good news because it means more revenue directed towards better serving the membership.

The second factor, **V**, represents the number of dedicated volunteers active in the League. The more people who have the ability, time, and desire to complete the tasks that need to be done, the smoother the AL can operate and the more preferred benefits it can offer.

It cannot be overstated that any success of the League is largely due to its many, many hard-working volunteers. If they don't do what needs to be done, things come to a screeching halt rather quickly. Right now, the volunteers number about 100 people. If that figure is in doubt, think of all the national and regional officers, all the Observing Program administrators, the *Reflector* staff, the web team, the awards judges, the trust fund trustees, the publications chair, the historian, the Book Service administrator, the Astronomy Day coordinators, and the convention planners and implementers. Their efforts are a strong sign of organizational success and help illustrate what the League is all about.



E, the third component, symbolizes the expenses incurred by the Astronomical League. This includes, but is not limited to, *Reflector* publishing and mailing costs; Observing Program and Awards Programs administrative costs; and national office insurance, rent, maintenance, and independent contractor fees. While it strives to keep expenses low, the League must always battle slowly but constantly rising costs.

The fourth part, **B**, results from the interplay of the first three. The revenue plus the efforts of volunteers minus any expenses should result in valued benefits. The more benefits, the better, resulting in a healthier League. (Please be assured that the League and its sponsors want members and clubs to take full advantage of the benefits.)

Consider some of the offerings of the Astronomical League:

- Over 50 Observing Programs;
- The quarterly *Reflector* magazine;
- Recognition awards program;
- The ten paths of Youth Awards;
- The Library Telescope Program;
- The Astronomics Sketching Award;
- The Imaging Awards;
- Astronomy Day Awards;
- Book Service;
- AstroNotes and Outreach Downloads;
- Celestial Savings Program;
- Dark-sky advocacy;
- And, yes, much more.

Judging from all its many benefits of membership, is the Astronomical League healthy?

"What's Past Is Prologue"

When William Shakespeare penned those thoughts in *The Tempest*, he may have foreseen the state of today's Astronomical League. All the volunteers marshaling all the resources provided by all the members have developed all the benefits. Past actions place the League in the good position where it sits today.

The League now faces its future. Because of its past, the "prologue" is a good one.

Epilogue

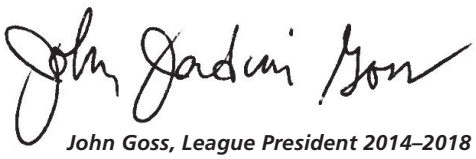
These thoughts on the state of the Astronomical League mark the sixteenth and final appearance of this quarterly column that has often focused more on the "why" of amateur astronomy than on the "what" or "how." A League president can serve no more than two consecutive two-year terms, and this president's second term will have ended on August 31.

Over these past twelve years as a national officer, I have had the privilege to meet with many Astro-Leaguers and other members of the amateur astronomy community from around the country (and the world). Space limitations prevent me from specifically naming all those volunteers who have contributed mightily to the success of the Astronomical League. I am grateful for the support I consistently received from the national and regional officers, the *Reflector* staff, the ALCon organizers, the Observing Program coordinators and administrators, the web team, and the national office staff—as well as many others.

Two people deserve special mention. Bill Bogardus, your incoming president, has supplied wise and prudent counsel since he joined the executive committee as secretary in 2009. My wife, Genevieve—an avid amateur astronomer herself—has given welcome and valuable assistance to the League and me since I first became secretary of MERAL in 2001.

Thank you, everyone, for the opportunity to have served as your Astronomical League president!

"All good things must end"—variation of a proverb by Geoffrey Chaucer.



John Goss, League President 2014–2018

Minneapolis is great this time of year: warm (mid-90s), humid (some days the humidity is higher than the temperature), and somewhat buggy (flying types). The hotels are cool and dry, with excellent food, and the Hilton Minneapolis/St. Paul Airport Mall of America was no exception. ALCon 2018 was in town and some 300 Astronomical Leaguers were there to hear the speakers, view the vendors, and connect (or in some cases, reconnect) with each other. See the full report elsewhere in this issue.

At the annual council meeting (held the Wednesday before ALCon), the winners of the recent elections were revealed: for president, Bill Bogardus; vice president, Ron Kramer; executive secretary, Maynard Pittendreigh; and treasurer, Bill Dillon.

Since I was elected vice president, it was prudent for me to resign as editor of our quarterly magazine, the *Reflector*. The new *Reflector* editor is John Martin. John is originally from New York and currently lives in Minnesota. He has been our associate editor for the past several issues and was the natural choice for promotion.

I must say that the past five years as *Reflector* editor have been very exciting and enjoyable. The staff, all volunteers, have continually produced an excellent journal, comparing in quality, imagery, and professionalism with *Sky & Telescope* and *Astronomy* magazines. Specifically, I wish to give my deepest thanks and appreciation to the following people:

Carla Johns, Advertising Representative
Chuck Beucher, Design/Production
Dan Crowson, Photo Editor
John Wagoner, Coming Events Editor
Kevin Jones, Assistant Editor
Kristine Larsen, Assistant Editor
John Martin, Associate Editor

Without these individuals, the *Reflector* could not reach, nor maintain, the level and readership (approaching 18,000) it has today.

I also wish to thank the imagers, writers, and contributors. Without them, we would be publishing a 32-page magazine of blank pages.

Finally, I want to thank you, the readers. You are why we produce the *Reflector*.

This is my final writing of Reflections, but I will retain my duties of managing editor, which gives me oversight of the entire picture, including printing, publishing, and the rest of the "behind the scenes" activities. Thank you all for your continued support. May you continue to have clear skies.

Ron Kramer

International Dark-Sky Association

LEDs and Skyglow

The light-emitting diode (LED) revolution has arrived. Most major cities have replaced or are in the process of replacing their current street lighting systems with LED fixtures. High-intensity discharge lamps, typically high-pressure sodium (HPS) or metal halide (MH), are no longer being used for new street light systems. LEDs are reasonably energy efficient with respect to light emitted per watt of power used, but they have the considerable advantages of lower operational costs and maintenance costs. They do not deteriorate for many years, have lifespans of a decade or more, and can be easily dimmed or otherwise controlled.

The use of LED street lighting has the potential to save municipalities large amounts of money over the long run. The bad news in this is the very distinct possibility that LED replacement systems will add to skyglow by increasing the lighting levels on the ground since the long-term cost for lighting is less than it was previously. It is not an uncommon phenomenon for users of a commodity to increase their use as its costs go down rather than continue the same use and save money. There is anecdotal evidence that some municipalities have increased the number of fixtures and/or the lighting levels on the ground when converting from HPS or MH systems to new LED street lighting. Also, some of the early LED systems had increased emission at the blue end of the visible light spectrum, increasing perceived glare and increasing scattered light into the sky, compared to prior HPS systems, which were mainly in the red end of the visible light spectrum. The end result is unfortunately often a "rebound effect," which results in the emission into the sky of more light than existed prior to the LED conversion.

The city of Tucson converted municipally owned street lights from a mixture of HPS and low-pressure sodium (LPS) to 3000-Kelvin white LED fixtures. These are considered "warm" with a bias toward the red end of the visible light spectrum. John Barentine, director of conservation at IDA, was the lead investigator studying the effects of this conversion on the skyglow over Tucson. According to their report, the team led by Barentine "obtained direct and indirect measurements of the luminance of the night sky from 15 locations in and near Tucson, Arizona, during two epochs in June 2014 and May–June 2017, in between which the City of Tucson converted ~18,000 municipally-owned street lights from a mixture of HPS and LPS to 3000 K white LED, while reducing the number of photopic lumens emitted by the street lighting system by 63%."

The researchers measured a decrease in skyglow of about 7%. While this is slightly lower than the predicted decrease of 10–20%, it is an important result. I believe this study demonstrates one can convert the street lighting of a city from high-intensity discharge lamp lighting to LED lighting with a reduction of skyglow. I also feel this reflects the utility of an outdoor lighting code. Tucson's skies are far from ideal, with much work needing to be done to reduce light pollution and light trespass. However, the skies over Tucson are far better than would be expected for a metropolitan area of 1,000,000 persons. City and county lighting codes in southern Arizona designed to protect professional observatories, in my opinion, are reasonably effective, giving us skies far superior to what they would be without the codes. Certainly, a lot more needs to be done along these lines, but the codes are a good start. For more information, check out the formal study done by Barentine and his colleagues at *arxiv.org/abs/1802.03474* (Barentine, J.C., C.E. Walker, M. Kocifaj, F. Kundracik, A. Juan, J. Kanemoto, and C.K. Monrad, 2018, Skyglow Changes Over Tucson, Arizona, Resulting From A Municipal LED Street Lighting Conversion, *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 212, p. 10–23.).

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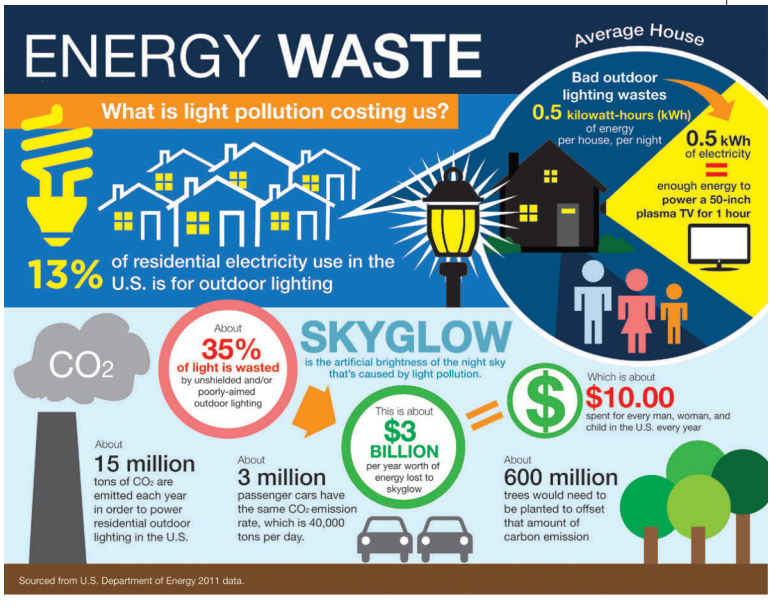
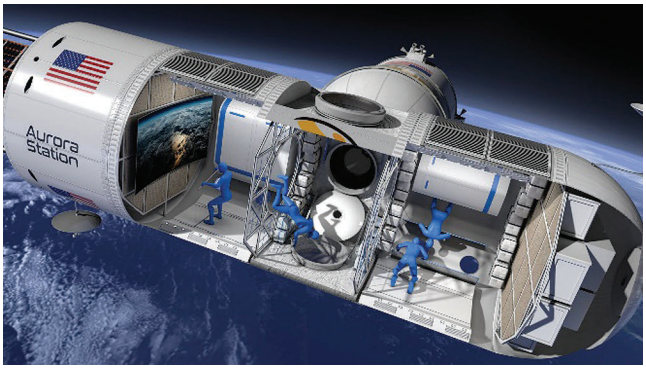


All Things Astronomical

New Use for Telecommunications Networks: Helping Scientists Peer into Deep Space

For the first time, researchers have demonstrated that a stable frequency reference can be reliably transmitted more than 300 kilometers over a standard fiber optic telecommunications network and used to synchronize two radio telescopes. Stable frequency references, which are used to calibrate clocks and instruments that make ultraprecise measurements, are usually only accessible at facilities that generate them using expensive atomic clocks. The new technology could allow scientists anywhere to access the frequency standard simply by tapping into the telecommunications network.

The ability to send stable frequency references over the telecommunications network could be particularly useful for radio telescope arrays such as the Square Kilometer Array (SKA), an international effort to build the world's largest radio telescope using arrays in Australia and South Africa. When complete, SKA will detect faint radio waves from deep space with a sensitivity about 50 times greater than that of the Hubble telescope. Individual radio telescopes will be linked to create a total collecting area of about 1 million square meters.



Linking radio telescopes in an array requires that each telescope have access to an atomic clock to record the precise time at which a signal is detected from an object in space. Focusing all the telescopes on the same object and then calculating the slight differences in the time for the signal to reach each telescope allows researchers to combine all the observations and pinpoint the object's location and other characteristics. Stable transmitted references could be used to calibrate the relative time at each telescope, eliminating the need for multiple atomic clocks in a radio telescope array.

In *Optica*, The Optical Society's journal for high impact research, researchers from a consortium of Australian institutions report on the successful transmission of a stable frequency reference between two radio telescopes via a fiber link and demonstrate that the technique's performance is superior to the use of an atomic clock at each telescope. The consortium included Australia's Academic and Research Network (AARNet), the Australian National University, the Commonwealth Scientific and Industrial Research Organization (CSIRO), the National Measurement Institute, Macquarie University, and the University of Adelaide.

The results show that the technique is capable of compensating for signal fluctuations in the fiber optic network introduced by environmental factors such as temperature changes or vibrations. The demonstration was even performed over a network that was transmitting live telecommunications traffic at the same time.

Testing with live network traffic

"By running the experiment on optical fibers also carrying normal traffic, we showed that transmitting the stable frequency standard doesn't affect the data or telephone calls on the other channels," said Kenneth Baldwin, a member of the research team from the Australian National University. "This is necessary to gain the cooperation of the telecommunications companies that own these fiber networks."

Continued on page 26

Treat Yourself to a *Sky & Telescope* Tour!

Northern Lights of Finland

March 25–April 1, 2019

skyandtelescope.com/finland2019

Join Finnish-American *S&T* editor Diana Hannikainen on this cushy tour from Helsinki to Lapland in search of the gorgeous aurora. Enjoy Finnish and Sami culture and cuisine, stargaze with a local astronomer, stay in a glass igloo, take a reindeer safari, relax in a Finnish sauna, and more.

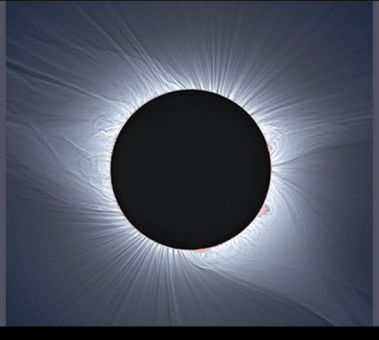
Chile 2019 Eclipse Flight

July 2, 2019

skyandtelescope.com/2019eclipseflight

From the vantage point of an A320 aircraft flying 37,000 feet above the Pacific Ocean, you'll be high above any clouds that might lurk below. And you'll see up to 3¼ minutes of totality (vs. 2½ minutes from the Chilean coast). Our flight will depart from Santiago, Chile, and return there after the eclipse.

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



2020 Eclipse Cruise: Chile, Argentina, and Antarctica

Nov. 27–Dec. 19, 2020

skyandtelescope.com/chile2020

Additional tours now in the works to Botswana, Australia, and Iceland.

Keep tabs on all *S&T* tours at skyandtelescope.com/astronomy-travel

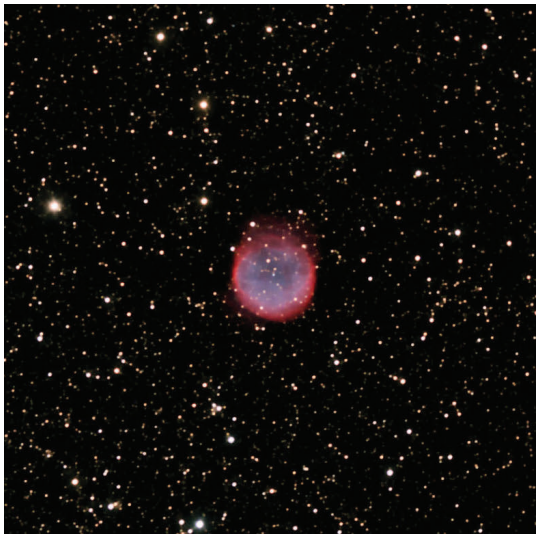
SKY & TELESCOPE

The Eagle's Best Nebula

By James R. Dire
Kauai Educational Association for Science and Astronomy

The constellation Aquila is one of the oldest constellations among the current 88 recognized by the International Astronomical Union. The constellation predates the Greco-Roman astronomer Ptolemy, who included it as one of the 48 constellations he described. Aquila is the Latin word for eagle.

In Greco-Roman mythology, Aquila was the eagle that held onto Zeus's (Jupiter's) thunderbolts. Aquila is also thought to represent the eagle that kidnapped the mythological Ganymede to serve as a cupbearer in Mount Olympus, the home of the Greek gods.



Aquila spans the celestial equator, from 15° north to 10° south, around 19 and 20 hours right ascension. The constellation can be seen equally well in both hemispheres in the evening from July through October. The constellation's brightest star is yellow-white Altair. At magnitude 0.76, Altair is the 13th-brightest star in the sky and is ten times more luminous than the Sun.

Aquila also lies along the Milky Way between Cygnus and Sagittarius. Two tiny constellations, Vulpecula and Sagitta, separate Aquila from Cygnus. But it's easier to find Aquila by looking halfway between the more recognizable Cygnus and Sagittarius. Whereas Cygnus, the swan, is pictured flying towards Sagittarius, Aquila, the eagle, is depicted flying away.

Despite lying along the Milky Way, and unlike Cygnus and Sagittarius, Aquila contains no Messier objects and no bright nebulae. Even tiny Sagitta and Vulpecula have Messier objects! However, Aquila does have one very fine planetary nebula worthy of inspection by anyone with an 8-inch or larger telescope: NGC 6781.

NGC 6781 was discovered by John Herschel in 1834. He found it using an 18-inch reflector. The nebula lies 8° west and 2° south of Altair. It is also 4° northwest of the third-magnitude star Delta Aquilae. I line up NGC 6781 knowing the planetary nebula, Altair, and Delta Aquilae form an isosceles triangle.

Like all planetary nebulae, NGC 6781 is a type of emission nebula consisting of an expanding shell of ionized gas ejected from a red giant star late in its life. Despite their name, planetary nebulae have nothing to do with planets. NGC 6781 is roughly 1.8 arcminutes in diameter and has an integrated magnitude of 11.4. Compare this to the planetary nebula M57, the Ring Nebula, which has a diameter of 1.3 arcminutes and is magnitude 8.8. M57 is 11 times brighter than NGC 6781. This is why M57 can be seen in a 3-inch telescope, but a larger telescope is required to see NGC 6781.

Visually, NGC 6781 is much easier to see in an 8-inch telescope than its magnitude dictates. The view is similar to M57 in a 3-inch scope at the same magnification. The nebula has a brighter outer ring with a dark interior. The 15th-magnitude central star is beyond all but the largest amateur light buckets. Like M57, no color can be seen in the nebula visually.

My image of NGC 6781 was taken with a Discovery 10-inch f/6 Newtonian with a Tele Vue Paracorr Type-2 coma corrector, yielding a 1753 mm focal length at f/6.9. The image was captured with an SBIG ST-2000XCM CCD camera with a 150-minute exposure. North is up and east to the left. The brightest star in the image, to the left of the nebula, is magnitude 11. The image captured stars fainter than magnitude 18. The camera captured the true color of the ionized gases. The bright red regions are ionized hydrogen emissions. The interior of the nebula contains faint blue emissions. Note the central star. The nebula is rounder than M57 and appears more like M97, the Owl Nebula, than M57.

While Aquila is mostly known for its myriad double stars and star clusters, NGC 6781 is a pleasing nebula to spy while panning across "The Eagle." Those with sufficient aperture will find capturing NGC 6781 a rewarding experience.

Making a Moon

By Berton Stevens

The most obvious astronomical object in our sky after the Sun is our Moon. These two are the only celestial objects whose disks can be clearly seen without a telescope. Even visible in daylight, the Moon becomes a bright lantern when hanging in the night sky. Even though it only reflects eighteen percent of the sunlight that falls on it, the full Moon illuminates the night sky, allowing only the brightest stars to be visible.

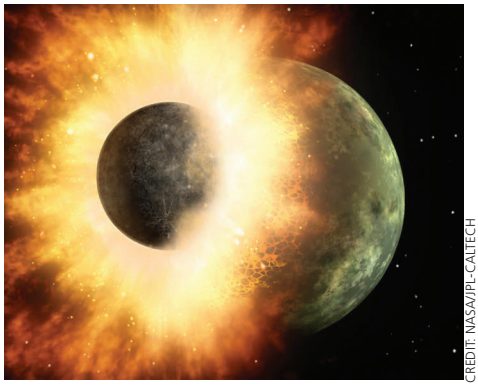
The Earth–Moon system is unique among the planets in the Solar System, with the Moon containing an unusually high 1.2 percent of the mass of the system. (For comparison, the dwarf planet and Kuiper Belt object Pluto and its largest moon, Charon, are a more extreme example—Charon contains about 11 percent of the mass of the Pluto–Charon system.) Most planets' moons are so small that their mass is negligible compared to the host planet. Because our Moon is so massive, the actual focus of the Moon's orbit is not at the center of the Earth, but at a point roughly 2,902 miles from the center in the direction of the Moon. This is the center of mass of the Earth–Moon system, called the barycenter. The Earth and Moon swing around this point like two children with arms linked circling each other.

On average, the Moon is 238,800 miles from the Earth, but its actual distance varies, not only due to the Moon's location in its orbit, but also because the orbit itself changes slowly over time. Nevertheless, it is close enough that the Apollo astronauts could get there in three days. During their visits, several hundred pounds of Moon rock were collected and returned to Earth.

Analysis of this rock has shown that, geochemically, the Moon is virtually identical to the Earth. Atoms of a specific element, such as oxygen, always have the same number of protons in their nuclei, but the number of neutrons can vary. Atoms of the same element with different numbers of neutrons are called isotopes of the element. Comparing the ratio of the common isotope of oxygen, with eight neutrons, to the other two isotopes (with nine and ten neutrons, respectively) provides one signature of a sample of the gas. Depending on where a planet forms in the Solar System, the isotopic ratio will be different. For the Earth and Moon, they are the same.

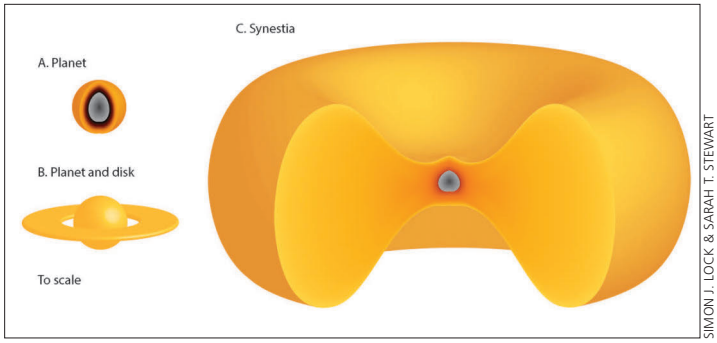
An early model for the formation of the Moon had it splitting off from a rapidly spinning Earth. The Pacific Ocean basin was the purported former location of the material that became the Moon. This model was discarded when it was discovered that the Pacific Ocean basin was only two hundred million years old, while the Moon is 4.51 billion years old.

The relatively large mass of the Moon makes it difficult for astronomers to construct a model for its formation. If it had formed somewhere else in the Solar System, it would have flown past the Earth so quickly that Earth's gravity would have been unable to capture it, and it would also have a different isotope ratio than the Earth. Another hypothesis has the Earth and Moon forming together near the beginning of the Solar System. This idea also has a number of problems; one is that it does not explain how eighty percent of the angular momentum in the system ended up in the Moon, or why the Moon's iron core only occupies twenty-five percent of its radius while the Earth's core occupies fifty percent of its radius. They should both be the same percentage if they formed out of the same material.



CREDIT: NASA/JPL-CALTECH

*One hypothesis for the formation of our Moon has a Mars-sized planetesimal named **Theia** striking a glancing blow on the primordial Earth. The impact scattered the remains of Theia and material from the Earth into space. Some of this material formed a ring around the Earth that eventually condensed into the Moon.*



SIMON J. LOCK & SARAH T. STEWART

*Formation of the Moon may be the result of a **synestia**, a bagel-shaped cloud of material that formed after the impact of Theia with the Earth, destroying both. The Earth reformed in the center of the synestia, while the Moon formed from the outer doughnut. Eventually, all the droplets of hot material became part of the Earth or Moon.*

A newer model was devised in the 1970s, called the giant-impact hypothesis. It has a Mars-sized planetesimal, dubbed **Theia** after the mythological mother of Selene (the Moon), making a glancing blow against the still-molten Earth. This knocked a great deal of material off the Earth and tilted its axis to its current 23.4 degrees. Some of the combined material from Theia and Earth escaped into the Solar System, while some fell back to Earth. The remainder went into orbit around the Earth. This mix of Earth and Theia material eventually coalesced to form the Moon. The Apollo Moon rocks showed the Moon had nearly the same composition as the Earth, so what happened to the material from Theia?

Perhaps material from Theia is in the mix that formed the Moon, but this would require that Theia have had exactly the same composition as Earth. Since each body in the Solar System has a different composition based on temperatures and materials in the region where they formed, this is unlikely. For Theia to have had the same composition as Earth, it would have had to form in the vicinity of the Earth, excluding the possibility of a high-speed impact.

A variation of this idea has a larger Theia hitting the Earth more centrally, shattering both planets. The mixture of Theia and Earth material that did not escape into the Solar System formed a giant bagel-shaped cloud called a **synestia**, larger than the Moon's current orbit. The outer torus of the bagel is still connected to the middle and droplets of molten rock circulated freely throughout the synestia. This material slowly cooled and condensed into a central planet, while the outer torus of the bagel formed the Moon. Since both were reformed by this event from the mixed material, they would have ended up with the same composition. Unfortunately, no one has ever seen a synestia anywhere in space.

Another hypothesis has up to a dozen impactors striking the Earth at different speeds and from different directions. Each impactor would create a disk of Earth-like material around the Earth that eventually cooled to form a proto-moon. The impactors did not all strike at the same time, and the Earth must have had an assortment of proto-moons orbiting it. The individual proto-moons would eventually collide to form larger proto-moons. When they all had been combined, the result would be our Moon.

Curiously, there is a type of meteorite (and asteroid)—an enstatite chondrite—whose composition is almost the same as Earth's composition. Could these have been the type of planetesimals that coalesced to form both Earth and Theia? If so, then the giant-impactor hypothesis may be viable. Our understanding of the formation of the Moon, and in fact the entire Solar System, is still evolving. More observations and the chemical analysis of other planets' compositions will help us understand our history.

Great Observing and, Reference Materials!

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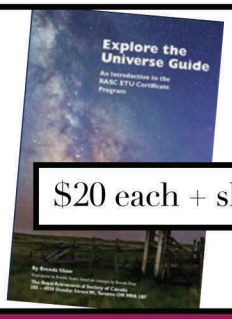

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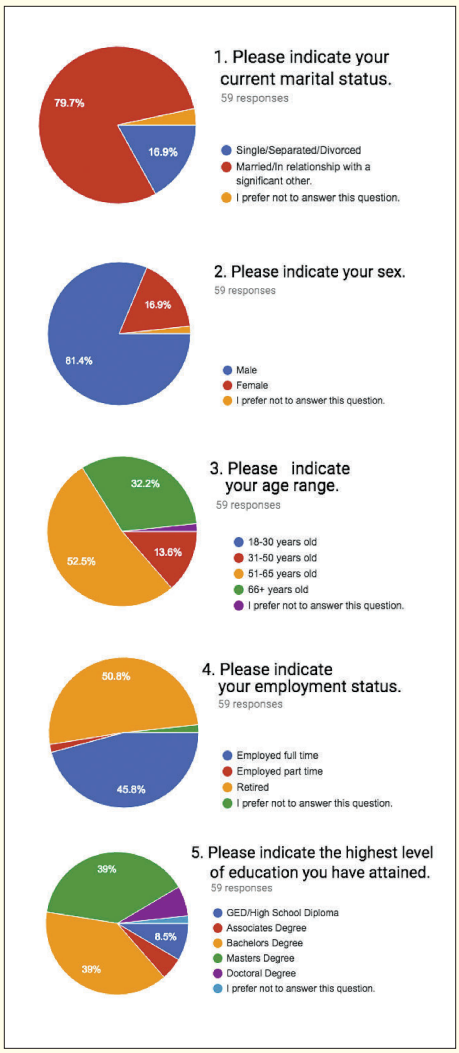
Sea Changes in NCRAL

Carl Wenning, NCRAL Chair

The North Central Region is among the largest regions in the Astronomical League with some 1,900 members. It is one of 11 regions that make up the Astronomical League. We have held an annual convention each year since our founding in 1947 when we came into being along with the AL. With seven member states—Illinois, Wisconsin, Minnesota, Iowa, North and South Dakota, and the Upper Peninsula of Michigan—it's hard to maintain any semblance of activity throughout much of the rest of the year. The North Central Region of the Astronomical League (NCRAL) is now undergoing a sea change that should allow it to become a greater benefit to its affiliate clubs than ever before.

In an effort to learn more fully about the wants and needs of our region, the present leadership reestablished its newsletter, developed a self-service email sign-up list, developed and conducted several surveys, developed a regional convention guide, developed two grant programs, and increased the use of a website and social media. The leadership is now working on establishing observing programs to supplement the work of the Astronomical League and to satisfy the interests of our members. We also are currently holding an NCRAL logo competition.

Our *Northern Lights* newsletter was resurrected during the summer of 2016. Each issue contains notes from the regional chair and newsletter editor, as well as a variety of articles written by members of the region's affiliates. The newsletter is published as a PDF so it can be produced in color and widely distributed with no concern about printing and distribution costs. Recent issues have been in excess of 20 pages each. We previously used a network of affiliate presidents, ALCors, and newsletter editors to distribute the newsletter, but we have developed an online membership sign-up for an email list so that we can get newsletters and announcements out to the region on a timely basis. We are also taking advantage of Facebook to provide observing updates and reminders about once per week.



Some demographic results from our recent convention preferences survey

We have conducted several surveys to learn about membership wants and needs dealing with goals for the region, and how best to improve the region's offerings so that it might channel potential affiliates into Astronomical League memberships, and, by default, NCRAL memberships. These results have, or will very soon, be published in the region's newsletter. Based on both a post-convention survey and a convention preferences survey we have created our region's own convention planning guide which considers member preferences. We are expecting to see significant changes in how our region's conventions operate as a result of these surveys. The regional council recently approved two mini-grant programs. The first deals with affiliate membership recruitment and retention; the second deals with affiliate recruitment which is geared toward getting more organizations in the region to join the Astronomical League. The first grants will be awarded at our NCRAL 2019 meeting to be held in Moline, Illinois, May 3–5.

A surprisingly large number of our affiliates' members have never completed an AL Observing Program. In the future, the NCRAL will be working on several observing programs to help affiliate members transition to completing AL-sponsored programs. Among such programs are Mini-Messier Marathons that will consist of seasonal lists that can be completed on a given night without too much effort. This reflects the fact that nearly one-third of our membership is at least 66 years old and that more than half is between 51 and 65 years old. Work is also underway to develop an astronomical "bucket list" for our region's members which will focus on viewing celestial objects "one last time" before we bid them a fond farewell.

To see the results of these efforts you may access the NCRAL website, which documents most of these activities. Visit us at *ncral.wordpress.com*. You may also email the author with your questions at *carlwenning@gmail.com*.

White Snow on the Seven Dwarves

Dave Tosteson
Chisago City, Minnesota
djtost1@gmail.com

As the Great Depression rocked economies around the world, the suggestion of a young English girl connected the genius of two American men whose discoveries and imagination reverberate to the present. Clyde Tombaugh was a young and eager amateur astronomer who took the challenge offered by Percival Lowell to come to Flagstaff and search for a new planet beyond Neptune. The story of how the man from Kansas made his way to Lowell Observatory to "blink" photographic plates for months to accomplish this is legendary. On February 18th of 1930, he announced the discovery of the first planet found in our Solar System since 1846. Venetia Phair (née Burney) was an eleven-year-old girl in Oxford, England, and offered the name Pluto, the Roman god of death. This was consistent with the naming pattern for the other planets, Tombaugh liked it, and all the astronomers at Lowell Observatory voted in agreement.

Walt Disney was animating short pieces during this time, and introduced a floppy-eared, unnamed dog that tracked the escaped Mickey Mouse in the canine's first film, "The Chain Gang." He was promoted to a pet of Minnie and, by his third film "The Moose Hunt" in 1931, became Mickey's companion with a new name. No official document ties the name Pluto to that of the freshly found planet, but animators' recollections say Walt Disney used the popularity of the new planet for his pooch, who earned his own movie a few years later. In 1937, Disney used a fairy tale by two German brothers as the basis for his first animated feature film about a young girl, exiled for her beauty, who got by with some help from her friends.

The discovery of Pluto changed the way we perceived our Solar System. It was an important clue about unusualities that are awakening us, decades later, to a larger and more complex local family. The asteroid belt was found to contain bodies that didn't fit. Some of the planets' moons didn't adhere to normal orbital patterns. Many of the small, outer ones of Jupiter, Saturn, and Uranus revolve backwards and follow tilted orbits. Pluto's orbit had greater ellipticity and inclination to the plane of the ecliptic than those of the other eight planets, and it was locked into resonance with Neptune. I met Mr. Tombaugh in the early 1990s at his talk for the University of Minnesota and, though his body was frail, his mind was clear and sharp, and he kept us rapt with interest and appreciation. But even the reputation and accomplishment of Tombaugh were not enough to stem the tide of professional opinion when an ever-growing body of bodies threatened the rigid inventory of what were termed "planets." Three-quarters of a century after Pluto's discovery, reclassification of smaller bodies within the Solar System caused a mild upheaval centered on the emotional and historical connection of Pluto with the eight larger planets. In 2006, the International Astronomical Union (IAU) voted to retain only that octet and recast Pluto as a "dwarf planet."

Criteria for inclusion in this new category were three: that the body considered was not a full-fledged planet (one that "cleared" its path); that it orbited the Sun directly and not another body (as would a satellite); and that it attained "hydrostatic equilibrium," where its gravity produced a stable spherical or oblate shape. Pluto shares the orbital space of Neptune in a resonance, and so does not qualify as a planet. Charon circles Pluto and is considered its moon. Ceres is round and in equilibrium, but orbits in a region with thousands of other, smaller bodies, and so is a dwarf planet. Vesta has the distinction of being one of only two known *former* dwarf planets. It was once in equilibrium and almost round, but two large impacts on its southern side deformed it. The internal heat that shaped this large asteroid belt body had dissipated to the point where reduced plasticity did not allow return to a spheroid shape. Gravitational field measurements by the Dawn spacecraft confirmed this, so Vesta was designated in category as a minor planet before it even had a chance to enjoy dwarf planet status.

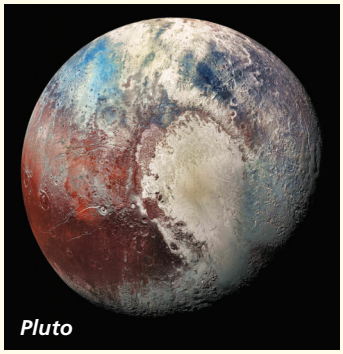
When Dawn arrived at Ceres in March 2015, one of its main goals was to investigate "bright spots" imaged during the journey from Vesta. Occator Crater is one of the youngest on Ceres and contains the brightest region on Ceres, Cerealia Facula. The best explanation of these areas is impacts that uncovered and deposited salts onto the surface. Ceres is the largest body in the asteroid belt between Jupiter and Mars, and the first found in that region, by Piazzi on New Year's Day 1801. It is the only asteroid belt body large enough to have retained a spherical shape, and the only dwarf planet to stay completely within Neptune's orbit. Evidence of cratering and subsurface plasticity suggests Ceres may have migrated to its present position from the outer Solar System. Vesta is the brightest object in the asteroid belt as seen from Earth, as it orbits both closer to us than Ceres and has a higher albedo: 42 versus 9 percent. Findings of hydrated minerals in its soil and half-mile-long gullies suggest a history of water on its surface. Polar temperatures may never exceed –200 degrees Celsius, allowing water ice to survive in its top ten feet of soil. In favorable orbital alignments, Vesta attains naked-eye brightness, as it did this past summer, in June 2018.

The Kuiper Belt extends from the orbit of Neptune (30 astronomical units, AU) out to 50 AU, and is estimated to contain over 100,000 bodies larger than 100 km in diameter. Pluto was the first body found within this region, and some of the outer planets' moons, such as Neptune's Triton and Saturn's Phoebe, are thought to be captured Kuiper Belt objects (KBOs). The belt may have about 200 bodies that would qualify as dwarf planets, and the Oort Cloud that stretches halfway to the nearest star might possess 10,000. By 2016, the IAU accepted five denizens as dwarf planets: Ceres, plus four KBOs: Pluto, Eris, Haumea, and Makemake. The first two KBOs are nearly equal in size at 2,300 km in diameter, and 800

km larger than the third largest Kuiper Belt body, 2007 OR_{10}. Two other KBOs, Quaoar and Sedna, are larger than Ceres.

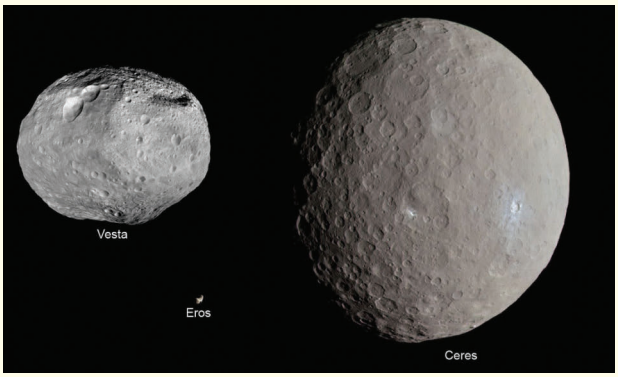
Since the turn of the millennium, we have received a wealth of data from dedicated searches for these bodies. Missions such as Dawn in the asteroid belt, and New Horizons that explored the Pluto system in July 2015, are returning beautiful images and invaluable, unpredicted information such as Pluto's multilayered atmosphere and variegated terrain with a history of plate tectonics. Charon has a canyon crossing its whole diameter, spanning a greater percentage of its parent body than even Valles Marineris on Mars. Origin theories about this "double-planet system" suggest a collision with Pluto early in their formation, similar to but less violent than the one thought to have formed Earth's Moon. New Horizons is scheduled to visit a second Kuiper Belt object in early 2019. The list of known bodies that may qualify as dwarf planets is growing, including one hundred larger than 400 km in diameter and another hundred larger than 300 km. Of this bounty, what is visible to an amateur? How many of these distant worlds can we see at the eyepiece?

Michael Brown of Caltech has been the foremost researcher identifying and studying dwarf planets. He spearheaded our former ninth planet's demotion, gaining infamy as the "Pluto Killer." As an appeasement, his young daughter suggested he find a replacement, something he has done in spades by helping discover Eris, Sedna, Haumea, and Makemake, among many others. Brown's updated website on dwarf planets informs our search for



Pluto

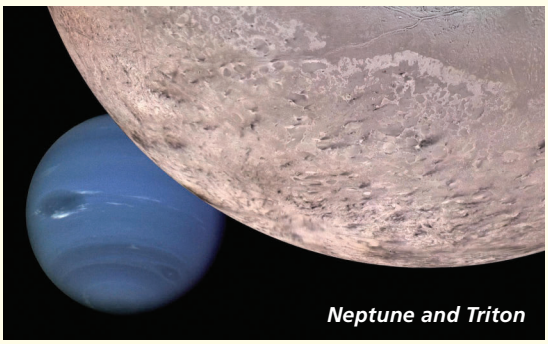
visual recovery. In January 2016, he and Konstantin Batygin, also of Caltech, calculated that the orbits of many recognized and potential dwarf planets suggested an influence by a larger body in the outer Solar System beyond Neptune. Estimated at ten times the mass of Earth (5,000 times that of Pluto), and located at twenty times the distance of Neptune, this new "ninth planet" would carry an elongated orbit taking about 15,000 years to circle the Sun. If it is 24th magnitude as predicted, it is presently out of reach for amateur visual observation. No one has yet seen it, but it's likely a wonderful world of color. Hmm, what could we name it?



When I started observing in the mid-1980s, Pluto was considered something of a challenge. The issue was not its dimness (its magnitude ranged from 13.6 to 16.3), but stemmed from needing to monitor the planet over a period of time to see it move among the background stars. Computers with digitized Sky Surveys and detailed charts to 13th or 14th magnitude were not available, and one relied on copied images and coordinate charting to make drawings on at least two occasions to confirm the sighting. I used my 10-inch f/5 reflector on several occasions to do this, a thrill at the time to complete the visual Solar System planetary survey. In recent years, amateurs have gone on to observe Pluto's largest moon, Charon, as an elongation when they were most separated in the plane of the sky. The other four moons of Pluto range from 23rd to 27th magnitude, too faint for eyepiece recovery. The Minor Planet Center of the International Astronomical Union and JPL maintain ephemeris services where amateurs can access positional and brightness data on dwarf and minor planets.

Ceres orbits in a mildly elliptical manner, varying from 382 to 443 million km from the Sun, with a magnitude ranging from 6.6 to 9.3. It can easily be seen in binoculars, and in excellent conditions an experienced observer can spot it without optical aid. To my knowledge, its bright spot, at the center of Occator Crater, has not been observed.

Once upon a time, Vesta was a dwarf planet. For the sake of making it to the magical number of seven, we will flaunt officialdom and "grandfather" it into our list. It has a mean diameter of 525 km, and is considered the last rocky protoplanet for its differentiated internal structure. Its 220 km core is nickel-iron, and it hosts an olivine mantle and a 10 km deep crust resurfaced by lava and eruption. Its density of 3.5 g/cm^3 is greater than almost all other asteroids, and among planetary satellites only Io is denser. It is the source of "HED" meteorites that have told us much about its structure and history, and carries three "snowman" craters whose bright areas are likely extruded salts. Because of its deviation from hydrostatic equilibrium, it is excluded from the dwarf planet manifest. I first spotted it in my 18-inch telescope in 1992, and fifteen years later, during a favorable apparition, my son Sam and I were able to see this sixth-magnitude minor planet without optical aid from our Minnesota home.



Neptune and Triton

In January 2005, a new body in the outer Solar System was discovered, almost a "twin" of Pluto. It was initially thought to be slightly larger than Pluto, a claim that took detailed observations by New Horizons to clarify. Though now known to be a few tens of kilometers smaller, this new dwarf planet, named Eris after the Greek goddess of strife, is 27 percent more massive than Tombaugh's find. By a statistical coincidence, it has 0.27 percent of Earth's mass. Eris is three times more distant than Pluto, a factor allowing methane to condense onto its surface and cover the reddish deposits of tholins that are so prominent on Pluto. This white coating increases its reflectivity, brightening it for visual observation. Eris carried a magnitude of 18.7 (V) as I searched from the 2006 Okie-Tex Star Party in the windiest conditions in which I had observed. Hurricane force winds pummeled the camp that week, scattering belongings, ripping tents, and overturning structures, all in a clear-blue morning sky. In the predawn hours of September 20th, I used

my 32-inch reflector with the shroud removed, but the wind still required my friend Tim Parson to stabilize the mirror box to minimize motion. The exchange between observers failed several times and we started the iterative process again and again, requiring over an hour to make one observation. We were certain of our sighting, but my documentation by drawing was inadequate, so I tried again in calmer conditions on October 7, 2010, using the same instrument with a 9 mm eyepiece giving 361x. By that date, the dwarf planet had moved ninety arcminutes to the northeast, positioned 2.8 degrees almost due west of NGC 702 in north-central Cetus. Using MegaStar with the 21st-magnitude USNO stars as a guide, Eris was seen at 1h 40m 16s right ascension, –4d 16m 15s declination, about 22 arcseconds east of a 19th-magnitude star, at 3:30 a.m. CDT. The brightest nearby star was 2.4 arcminutes to the northeast at magnitude 12.2. Conditions that week prevented a second sighting.

In 2003, the team of Brown, Trujillo, and Rabinowitz discovered another body about three times the distance of Neptune. They named it Sedna after an Inuit sea goddess, and its orbit caused difficulty for dynamicists. It was found near its perihelion of 76 AU, with its calculated aphelion of 936 AU at the time farther than any known, non-cometary Solar System object. No one could figure out how it got there. Eris's aphelion was only 97 AU, likely flung by Neptune's gravity into what is called the "scattered disk," but Sedna could not have been placed into its position by Le Verrier's worldly find. Hypotheses explaining its orbit include gravitational influence by forming cluster siblings of the Sun sending objects such as Sedna and 2012 VP_{113} into an intermediate zone some have called the "inner Oort Cloud" between the Kuiper Belt and the classic Oort Cloud. It is one of the reddest bodies in the Solar System, with an albedo much lower than that of Eris. This and its smaller size make it 3.4 magnitudes dimmer than Eris.

Failure can define limits, so I decided to attempt the faintest of these newly found bodies. At the 2008 Okie-Tex Star Party I made charts for Sedna in southwestern Taurus. Its magnitude of 21.1 matched the faintest object I had observed, so I brought all the ammunition I could muster: POSS2 and SDSS images and USNO/MegaStar charts. Still air, low humidity, and seeing and transparency of 8/10 at 5:30 a.m. CDT on October 3rd allowed me to push my 32-inch f/4 scope, using a 3.5 mm eyepiece, to 929x with a 5.3-arcminute field of view. There is a reference triangle of stars at 3h 27m 5s right ascension, +6d 24m 48s declination. East of this is a faint, 19th- or 20th-magnitude star at 3h 27m 18s, +6d 25m 25s. Forty-five arcseconds slightly north of west from that star is a faint, nebulous object that was observed in the 32-inch, and 25 arcseconds south-southwest of that was an even fainter object at the edge of vision that was seen in the 3.5 mm Type 6 Nagler eyepiece several times. It did not show on my printed POSS field image, but later examination of the digital POSS and the SDSS did show a very faint object at the position: 3h 27m 15.2s, +6d 24m 57s. It was too faint to be included as one of the Sloan photometric objects. Recalculation with more accurate positional and elevation data at a later time suggested the dwarf planet was several tens of arcseconds to the west-southwest, so although it was in my field of view, it was not included in my drawings. At this faint magnitude an observer would need to know where to look within a few arcseconds to recover such an object. This was frustrating because had I known its exact position, I felt visual recovery was possible in those rare conditions. I hope to soon renew my search at the same location with the same equipment. Careful field drawing would allow evaluation at a later date, a la Galileo and Neptune.

The relatively bright Makemake, at magnitude 17.0, proved a much easier target to recover, even from poor skies at the 2015 Texas Star Party. Using my 32-inch scope at 650x, with seeing and transparency of 4/10 and high humidity, I was able to see it well with direct vision at 12h 48m 36.2s, +26d 20m 56s, from the upper field of the Prude Ranch at 3:50 a.m. CDT on May 16th, along the south-southwestern edge of a right triangle of magnitude 12 to 14.4 stars 4 arcminutes south of galaxy CGCG 159-80 in northern Coma Berenices. Haumea is the brightest of the remaining official objects, at magnitude 17.3, and was favorably placed in 2016 for northern observers at a few degrees southwest of Arcturus. It is the largest member of the only identified family of collisional fragments in the Kuiper Belt and owns a chaotic and eccentric orbit in resonance with Neptune. From my home on July 31, 2016, I used my 32-inch f/4 reflector at 650x after sunset to spot this rapidly rotating oblate interloper in Boötes, and repeated the observation with the same equipment four nights later. The latter position was 14h 1m 35s, +17d 17m 12s, at 10 p.m. CDT, and Haumea was noted to be gone from its late-July position. The dwarf planet had moved 4.5 arcminutes southeast in hat time.

In our survey of Pluto's stepchildren, that leaves one dwarf planet to go. Let's allow Triton, the large moon of Neptune discovered by William Lassell only 17 days after the planet was announced, to be the last target. Triton is almost certainly a captured Kuiper Belt body, and the only large planetary satellite in the Solar System to possess a retrograde orbit. It may be considered, as Vesta is, a former dwarf planet. It is geologically active with nitrogen geysers, and, had it not wandered into Neptune's gravitational domain, would be considered the largest KBO, for its diameter is over 2,600 km. From Earth, it is magnitude 13.5, visible in a 6-inch scope. The glare of Neptune slightly affects its observation, but the moon appears to us several planet-diameters away so is easily spotted. *Sky & Telescope* has a Triton Tracker observing tool (*www.skyandtelescope.com/wp-content/plugins/observing-tools/neptune_moons/neptune.html*) that shows the location of Triton over its 5.9-day period.

In the current list of known and possible dwarf planets, four others deserve mention as possible targets for amateur visual observation. Orcus is a Plutino, like Pluto locked in a 2:3 resonance orbit with Neptune, but dynamically constrained to be in the opposite phase from Pluto, so at aphelion when Pluto is at perihelion, and vice versa. Its relatively bright magnitude of 19.1 results from a high albedo of 23 percent, possibly caused by past cryovolcanic activity. It is located in Sextans, best seen as a late-winter or spring object from southern latitudes or the Southern Hemisphere. Another Plutino, Ixion, is magnitude 19.6 and is presently in southern Ophiucus, heading northwest. I have plans to attempt faint Quaoar (19.3) and fair Varuna (19.9) in a star-cross'd fall. So don't be dopey, sleepy, or bashful. S'know happy is nothing to sneeze at, 'cause seven s'nuff. Undoc your scope and ungrim your hope, for grumpy you'll be if you see not a dwarf.

Mere Meir little ball
Who's the Phairest
of them all? ✵

ALCON IN RE

By Dave Falkner

In the fall of 2015, Brandon Hamil came to me as president of the Minnesota Astronomical Society with the idea that the MAS should host an ALCon—an Astronomical League convention. Brandon had attended a couple and loved them. They were in dark-sky locations like Las Cruces and Austin. He thought having the ALCon in the Upper Midwest was long overdue. I gave it some thought and said, "Sure, why not? How hard could it be?"

After two and a half years of planning with a very capable team, ALCon 2018 came to fruition July 11–14. Innovative ideas and thorough planning made this ALCon incredibly successful—one that will be remembered for years.

It began on Wednesday, July 11. This was primarily setup day for the vendors and check-in day for attendees. The AL board also held their annual meeting this day. The ALCon planning committee had targeted an attendance of at least 300, and we were thrilled that at the start of the conference we were at 335. By the time the conference concluded, we would have 363 attendees registered—the largest ALCon in recent history after Casper (which was an anomaly with the total solar eclipse). Registration check-ins went like clockwork thanks to exhaustive preparation by Jerry Jones and his team.

Hilton Minneapolis/St. Paul Airport

With the hotel's freight elevator out of order, one of our major challenges was getting the 8-foot Explora-Dome in the front door and up the stairs. Fortunately, the dome was flexible enough that it could be deformed to get it through the hotel's front door. Six people carefully maneuvered the bulky dome up the stairs. The remainder of the pieces were much smaller, and the dome was easily assembled in the space we had for it.

After the AL board's annual meeting, the meeting room was quickly converted into the historical astronomical equipment exhibit. Vintage telescopes, accessories, and documents were set up. It was a real blast from the past with a replica of Newton's original telescope, a Unitron, a Gebelein 8-inch, a Coulter CT-100, and many other great telescopes.

On Wednesday, attendees enjoyed a field trip to the Science Museum of Minnesota in the afternoon and the Bell Museum of Natural History and Planetarium in the evening.We also had a star party at Eagle Lake Observatory. Despite iffy weather, the 30 or so attendees who made it were able to see Jupiter, Saturn, and a couple of deep-sky objects.

Thursday began bright and early with many more attendees registering. The historical astronomical equipment exhibit was in full swing now as was the vendor expo. There were field trips to the John T. Tate Hall and Observatory at the University of Minnesota as well as the Bell Museum. In speaking with folks who attended these field trips, both were big hits. Visitors to Tate Hall saw the Warner & Swasey 10.5-inch telescope and were briefed on some ongoing research. The exhibits at the Bell Museum were fantastic, as was the planetarium show.

Meanwhile, back at the Hilton, the main speaker programs began. Lou Mayo from NASA outlined NASA's space science education program and how NASA and the Astronomical League are working together to engage the country in the many wonders of our universe.

Following Lou, MAS's own Dave Tosteson spoke about "Observing the Deep Sky." Dave talked about his experiences using both his 15-inch and 32-inch Dobsonian telescopes to observe some of the faintest observable objects in the night sky, including brown dwarf stars, gravitationally lensed arcs, and quasars.

Following lunch, featured speaker Bob Berman spoke. Bob is the author of the "Strange Universe" page in *Astronomy* magazine and drew upon his years of experience with star parties and astronomy trips for his talk. Bob's presentation, "Lessons from Hollywood: How to Create a Great Backyard Sky-Show," gave attendees tips and tricks to keep star party visitors engaged and leave them with a memorable experience that keeps them coming back for more.

A location mix-up meant our next scheduled speaker was unable to make it to the ALCon site, so we shifted the schedule a bit and Brandon Hamil, MAS's unofficial ambassador, gave his very popular talk, "The


Passing the gavel from John Goss to Bill Bogardus

N 2018 VIEW

Traveling Astronomer." Brandon travels quite a bit as part of his job. He makes it a point to visit local astronomy organizations and companies as he travels around the country. His presentation talks about some of the places he has visited and some interesting and innovative things some of these organizations are doing.

With a gap in the speaker schedule, MAS's outstanding outreach speaker, Ron Schmit, graciously offered to give a talk on the spot. MAS was highlighting our Eagle Lake Observatory (above) as part of ALCon, so Ron gave a nice history, with images, on the construction of the buildings and the equipment there. The Larson telescope was a central object throughout the history of ELO and he talked about the history of the telescope, how the MAS obtained it, and the fate of the telescope after it was replaced by the Meade 16-inch LX200.

The afternoon field trips included a repeat tour of the Tate Building at the U of M and a tour of the MAS Joseph J. Casby Observatory at the Belwin Conservancy. The weather deteriorated throughout the afternoon and storms rolled in by dinnertime. As a result, the imaging workshop, originally scheduled to be held at Cherry Grove Observatory, was moved to the Hilton. Even though there was nothing to look at, the presenters, Robert Miller and Doug Neverman, talked about tips and techniques for imaging and were quite informative. At Eagle Lake Observatory there was no viewing, but the HotSpot Classroom hosted presentations by Bob Morrow of Bob's Knobs and Bill Tschumy of Simulation Curriculum (Starry Night and Sky Safari), who talked about their products and their newest offerings.

Friday morning began with the continuation of the vendor expo and historical astronomical equipment exhibit. The lone field trip was to the Bakkan Museum displaying historic medical equipment and documents. In the Hilton's main ballroom, the morning session began with the announcement of door prize winners. Raffle tickets also went on sale for three prizes provided by astronomical equipment retailer Starizona.

The morning session included a second workshop featuring Dan Joyce, who gave a presentation and demonstration on mirror making.

Main ballroom speaker presentations began with a fascinating presentation by Dr. Jay McLaren entitled "The Eye as an Astronomic Instrument." He began by discussing the anatomy of the human eye and how it detects objects in both the daytime and nighttime. He then built on this discussion to talk about the best techniques for viewing various objects at the eyepiece, including techniques for detecting faint, low-contrast objects.

The next presentation featured Dr. Clem Pryke from the Institute of Astrophysics at the U of M. Dr. Pryke spoke about his work in Antarctica using specialized telescopes and detectors to measure the polarization of the cosmic microwave background in an effort to detect gravitational waves from the inflationary

ALCon co-chairs Valts Treibergs, left, and Dave Faulkner, right, with John Goss

Master Observers received their awards

Bill Bogardus and John Goss with student Astronomical League winners

Dave Faulkner, president, Minnesota Astronomical Society

period of the universe immediately following the Big Bang.

Following a break for lunch, we were treated to our next featured speaker for ALCon. Phil Plait is well known through his blog and social media as the Bad Astronomer. His talk, "Science Communication in the Age of Snapchat," was an informative and entertaining talk on using social media for communicating factual astronomy to the public. Various forms of social media reach people in different ways, and Phil talked about the best ways for using Facebook, Instagram, Snapchat, and Twitter.

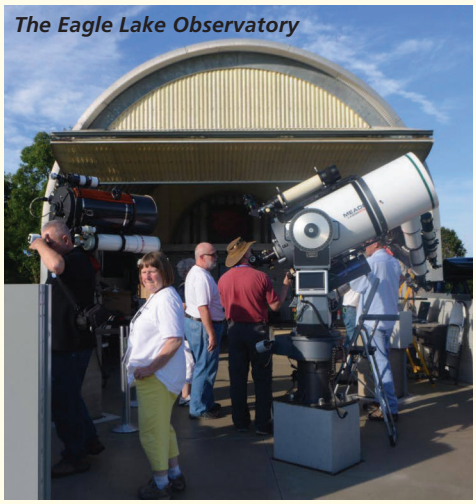
Dr. Terry Jones from the Minnesota Institute of Astrophysics was the next speaker. His talk, "Mass Loss in Hypergiants," raised the question of how these huge stars can survive with the volume of mass being ejected from their surface. If these stars replaced our own Sun, the surfaces of some would reach between the orbits of Jupiter and Saturn. The nuclear processes taking place in these stars are poorly understood and Dr. Jones' work is trying to unravel these mysteries.

The last afternoon event at the Hilton was a panel discussion with some of our speakers who are actively involved in outreach. The panel was moderated by Bob Berman and included Dr. Pamela Gay, Dr. Phil Plait, Bob King, and Ron Schmit. The panel talked about how we can attract women, members of minorities, and underrepresented demographic groups to astronomy and other STEM studies. They also discussed some of the issues with gender discrimination in academia and society. It was a lively and frank discussion that could have lasted hours, but we had to cut it short so we could make the evening's activities.

We broke from the afternoon's session and over 200 attendees traveled out to Baylor Regional Park and Eagle Lake Observatory for the Star-B-Q. The spread was at the pavilion by the lake with an extra tent because of the number of attendees who participated. The caterer Just North of Memphis served excellent pork and beef brisket barbeque with all the fixings. The Mr. Winky Band provided excellent live entertainment. The cloudy, stormy weather we had on Thursday gave way to clear, still skies for the evening. After enjoying the food and entertainment by the lake, folks migrated to Eagle Lake Observatory to observe the Sun and the daytime planets.

Dr. Pamela Gay with Abigail Bollenbach and Pranvera Hyseni

The Eagle Lake Observatory



There were two speakers at the HotSpot classroom that evening. Pranvera Hyseni from the Republic of Kosovo told her extraordinary story of how she and some of her friends brought astronomy to the people there. Her talk, "Little Things Make a Big Difference," revealed how social media allowed her story to spread throughout the world. She was invited to visit astronomy and space exploration sites around the world and meet people who would help her with her mission to spread astronomy to her country. She has been traveling around the United States speaking about her experience and mission. Telescopes and equipment have been donated to her organization, Astronomy Outreach of Kosovo, and she continues to spread her message of bringing astronomy to the people of this war-torn country.

With the opposition of Mars only a couple of weeks away, Richard Schmude, Jr., from the Association of Lunar and Planetary Observers (ALPO) spoke about techniques for observing the polar icecaps of Mars. Of course, actually observing them this time around may be a little challenging with the recent global dust storm on Mars.

Throughout the evening the ALCon attendees were treated to spectacular views of Venus, Jupiter, Saturn, and Mars thanks to clear skies and unusually still air for Minnesota. We couldn't have asked for a better night. Several attendees brought their telescopes and set them up around the observatory. There were reports that a couple of folks were able to observe Saturn's polar hexagon through a 23-inch telescope brought by Dan Joyce. It was a fantastic night for observing.

Saturday, July 14, was the final day of ALCon and it started with the Astronomical League Youth Awards and presentations. The National Young Astronomer Awards were presented to Vivek Vijayakumar and Pranti Modumudi. The Horkheimer Youth Service Awards were presented to Abigail Bollenbach, Tyler Hutchison, and Madison France Parks. The Horkheimer/Parker Youth Imaging Awards were given to Tyler Hutchison and Vivek Vijayakumar. The Horkheimer/O'Meara Journalism Award was given to Benedict Althoff.

The first speaker of the morning session was Kristen Finnigan. Her presentation, "Space Law 101: The Basics," delved into the existing international treaties and agreements as well as U.S. legislation around space exploration. She examined the history of space law, how it shaped some of the early space programs, and the future implications for government and commercial activities such as asteroid mining, human settlement, and on-orbit satellite servicing.

Next, Bob King gave his talk, "Summer Celestial Showstoppers: Getting the Public Excited about the Night Sky." Bob emphasized how it is easy to get the public excited about astronomy this summer with four planets visible, as well as a favorable night for the Perseid meteor shower on August 12. He talked about key weekends for observing, good locations for sidewalk astronomy, and tips on contacting the local media to get the word out.

After lunch, Dr. Larry Rudnick from the Minnesota Institute for Astrophysics at the University of Minnesota gave his talk, "Too Good to Be True?" This captivating talk explored the potential for life as we know it elsewhere in the universe, exploring the physical laws and examining whether life on Earth is a special exception, an accident, or whether conditions in the universe generally favor the creation of life.

The final presenter of the afternoon was Dr. Even

Skillman, director of the Minnesota Institute for Astrophysics. He talked about how the Panchromatic Hubble Andromeda Treasury (PHAT) program was created and talked in detail on how the amazing high-definition image of the Andromeda galaxy was made. He then went on to talk about how the Andromeda project enabled the largest systematic study of the distribution of the initial masses of stars. This data implied no significant dependencies of the distribution of initial masses on cluster age, mass, or size, providing direct observational evidence of a universal distribution.

The sessions adjourned to allow the hotel to set up for the Astronomical League Banquet that evening. The reception began at 6:30, and at 6:45 we had the raffle drawing for the Starizona donations. Katherine Hammad of Sumner, Washington, won the motorized focuser; Rich Willits of Ely, Minnesota, won the Hyperstar for a Celestron C8; and Erik Gisselquist of Cottage Grove, Minnesota, won the Hyperstar for a Celestron C11.

John Goss, president of the Astronomical League, announced the Youth Award winners of that morning. Then he presented the winners of the Mabel Sterns Newsletter Editor Award. The winners were Dave Thomas (Roanoke Valley Astronomical Society), Brian Thieme (Warren Astronomical Society), and Terry Dufek (Popular Astronomy Club). The AL Webmaster Award was presented to Shawn Loescher and Curt Lambert. The Leslie C. Peltier Award was presented to astro-imager Damian Peach. Several Master Observer plaques were awarded to those AL members who had achieved the distinction of Master Observer.

The Astronomical League's display with banner designed by president John Goss

The surprise of the evening was the presentation of the G.R. Wright Service Award for volunteerism that benefits the Astronomical League and its members. Our own Valts Treibergs and Dave Falkner were presented the award for their leadership in planning ALCon 2018. They were greeted with a standing ovation from the audience as they came on stage to accept the awards.

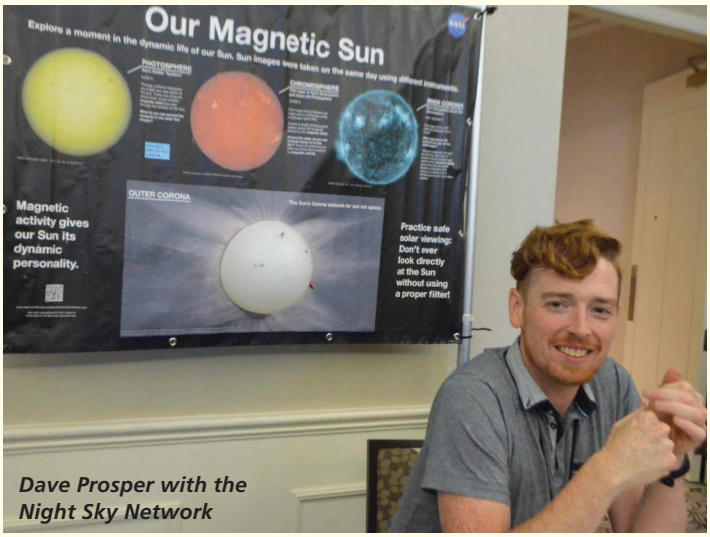
Before introducing the keynote speaker, Dave Falkner recognized the members of the ALCon 2018 planning committee whose hard work over the last two years produced an incredibly successful ALCon.

The keynote speaker was Dr. Pamela Gay, director of technology and citizen science for the Astronomical Society of the Pacific and the principal investigator of CosmoQuest. Her talk, "A Brief History of Great Amateur Achievements in Science," revealed how everyday people have done extraordinary things throughout the years, such as finding planets, observing emerging stars, and discovering the universe in new colors of light. She went on to discuss how anyone could become a citizen scientist and enumerated ways a person can become part of the scientific revolution in this new golden age of astronomy.

ALCon 2018 was a tremendous success. Many attendees commented how this was the best ALCon they had ever attended. It was even suggested that this ALCon would be the one future ALCons would be measured by.

Many thanks to the following members of the ALCon 2018 committee: Dave Falkner, Valts Treibergs, Jerry Jones, Mark Job, Brandon Hamil, Mark Connolly, John Poppele, Heather Birch, Antone Gregory, Trena Johnson, Robert Miller, Chris and Lilah Blinkman, Bob Kerr, Lauren Nelson, Roy Sarver, Andy Frasier, Stu Chastain, Mary Williams, and Suresh Srinivasan. Thanks also to Doug Neverman and Dave Venne for helping at the imaging workshop and to Dave Venne for creating the ALCon 2018 graphics. Finally, thank you to MAS president Clayton Lindsey for his support of the committee.

It took over two years to plan this and it was the dedication of the ALCon Committee that produced the best ALCon ever! I hope everyone enjoyed it.



Dave Prosper with the Night Sky Network


One of many talks held during the week

Abigail Bollenbach

Horkheimer/Smith Service Award

Abigail Bollenbach, a 16-year-old, home-schooled high school junior taking concurrent college courses this fall, plans to study her passions, astrophysics and astronomy, in college. She is outgoing and memorable and was selected for her outstanding service to her club and astronomy outreach.

Abby works in a biochemistry lab as a nanoparticulate specialist and an experimental research design assistant. She started astronomical studies at age 10 on a home computer via Khan Academy. Her first star party was at age 12.

She became a member of the Bartlesville Astronomical Society in 2015 at age 13. At that time, she was the only youth member of the organization, and she began working on outreach. In 2016, she started presenting monthly astronomy news via PowerPoint as well as presentations on topics including "Famous Rocket Crashes" and "How to Make A Camera Tracking Mount." She also set up and maintains an astronomy news Pinterest page for the club.

She was the principal organizer and founding member of the thriving Bartian Youth Astronomers, the only non-school-affiliated youth astronomy organization in the country. She provides news, main talks, is a greeter, new member sign-up person, and co–photo documentarian. She continues as a youth leader to assist and mentor at multiple outreach programs for local schools, libraries, and festivals. She gave a presentation to the Mid-States Region of the Astronomical League titled "Cassini-Huygens' Legacy."

Her many other activities include writing poetry, yoga, singing, photography, and astrophotography. In addition, she was the state first-place solo piano winner in 2015 at the Oklahoma Music Teachers Association competition and a seven-consecutive-year top winner of the National Piano Guild Auditions with the American College of Musicians. Abby retired from her 13-year dance career as company member ballerina for the Bartlesville Civic Ballet to work and save money for a car.

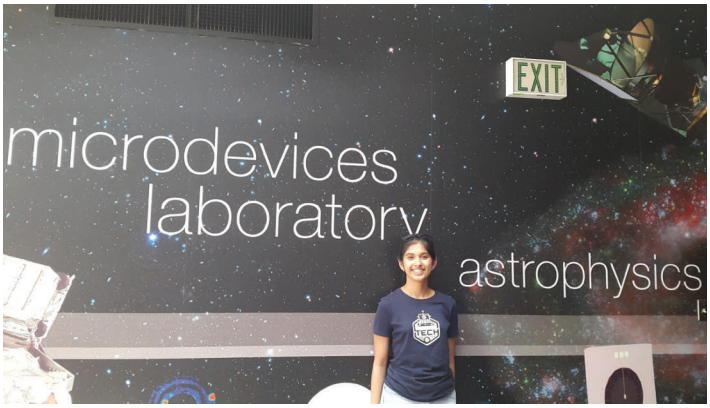
FROM AROUND THE LEAGUE

Pranati Modumudi

National Young Astronomer Award, second place—sponsored by Explore Scientific

Pranati is a rising senior student from Evergreen Valley High School, San Jose, California.

She is amazed by the vast universe, both within molecules and beyond the Earth and has been so since a young age. Since the beginning of high school, she has been involved in astrophysical research at universities.



Last summer, she conducted research on the amount of dark matter present in the Andromeda Galaxy. This year she was granted a leave of absence from her summer studies at the Simons Summer Research Program at Stony Brook University, New York, where she is researching cluster cosmology, to attend the 2018 ALCon award presentation.

When finished, she will be presenting research she conducted at the University of California, Santa Cruz on particle acceleration within the jets of the nuclei of active galaxies.

Her award-winning research project and paper was titled "X-Ray Study of Multiple Particle Acceleration Zones in the Blazar Mrk 421."

Benedict Althoff

Horkheimer/O'Meara Journalism Award, "Memories of the Great American Eclipse"

The Great American Eclipse on August 21, 2017, was the first solar eclipse in the United States in my lifetime. My hometown, La Crosse, Wisconsin, had only 87 percent of totality and so my family and I viewed the entire eclipse with special glasses. Even though the eclipse was occurring, it seemed as an ordinary bright summer's day, for the brightness of the Sun's rays overcame the Moon's shadow. If it were not for astronomers notifying those outside the band of totality, I would have missed the first solar eclipse of my lifetime!

My grandfather, an amateur astronomer, had a very different experience viewing the eclipse in totality in Casper, Wyoming. He told me his story. A shadow just suddenly consumed the valley where he was watching. The sky became a type of powder gray. The dogs next door were interesting to observe. Before totality, they were frisky and playing with each other. During totality, they became hushed and still. After totality, the dogs resumed their playfulness and started romping around again. Humans are not the only ones who can detect changes in the earth's behavior. All of totality was only 2 minutes and 26 seconds. Everyone was disappointed when the corona disappeared from view. Nobody was interested in the fading phase of the eclipse.

An eclipse is an obscuring of the light from one celestial body by the passage of another between it and the observer. When I viewed the Great American Eclipse of August 21, 2017, the Sun's light was obscured by the Moon passing between the Sun and me. There are two to five solar eclipses in one year. Most solar eclipse totalities last for two to four minutes. Right now, astronomers are studying eclipses so that we can be prepared to observe and enjoy them in the future.

Eclipses are fun to watch even if you are not an astronomer. The next total solar eclipse over the United States is on Monday, April 8, 2024. Be sure to mark your calendars! I hope to observe totality with my grandfather, and this time we can share the eclipse experience together. Life would not be as fun without eclipses!

—By Benedict Althoff, Age 10

Vivek Vijayakumar

National Young Astronomer Award, first-place—sponsored by Explore Scientific
Horkheimer/Parker Youth Imaging Award, second-place image of M8 and M20

Vivek is a rising star from San Marcos, California, who is interested in astrophotography and amateur astronomy and will be a sophomore in the coming school year. He got into astronomy at the age of eight after watching a lunar eclipse. Since then, his interest in imaging has earned him the 2017 Jack Horkheimer imaging award as well as this year's second place. He has been working on a project currently operating in the International Space Station and is involved with the San Diego Astronomy Association.

His work includes research on double-star astrometry with a paper pending peer review.

His work with planetary nebulae won first place in the 2017 California State Science Fair and in the Greater San Diego Science and Engineering Fair, where he was the sweepstakes winner in the physics and astronomy junior division.

His project on solar dynamics won first place in the Greater San Diego Science and Engineering Fair where he was the sweepstakes runner-up. He placed second in the California State Science Fair in the physics and astronomy senior division in 2018.

Apart from astronomy, Vivek is interested in physics and math and is a member of the San Diego Math Circle, president of the math club at his high school, and serves as a youth commissioner for the City of San Marcos. Other talents include playing trumpet and piano.

His winning research paper is titled "Analyzing the Expansion Rates of Planetary Nebulae."

Tyler M. Hutchison

Horkheimer/D'Auria Service Award
Horkheimer/Parker Youth Imaging Award, first place

Tyler M. Hutchison is a rising high school senior at St. Christopher's School in Richmond, Virginia. He is a youth member-at-large of the Astronomical League and a member of the board of directors of the Richmond Astronomical Society where he was elected at age 16. He actively participates in astronomy outreach activities through his school and the community by participating in star watches, Astronomy Day activities, and events at the Science Museum of Virginia.

He recently completed the Summer Academy for the Virginia Aerospace Science and Technology Scholars program at NASA Langley Research Center where he

FROM AROUND THE LEAGUE

worked on developing a hypothetical manned mission to Mars and presented the proposal to NASA scientists. He has also completed the Virginia Space Coast Scholars program through the Virginia Space Grant Consortium and was chosen to spend a week last summer at the NASA Wallops Flight Facility.

He has presented his research and findings on cosmic radiation at varying altitudes at the Junior Science and Humanities Symposium and is a winner of numerous school, local, and regional awards for his astrophotography including multiple Gold and Silver Key Awards through the Scholastic Art & Writing Awards. He also spent part of this past school year as an exchange student at Lindisfarne College in Hawke's Bay, New Zealand.

Tyler is a yearbook editor as well as a freelance photographer for other school publications and a member of both his school academic quiz bowl team "Battle of the Brains" and the Science Bowl team.

Winning astrophotograph, "Milky Way"

He is a three-year intern at the Science Museum of Virginia including social media work and climatology research. He founded the Environmental Awareness Club at his school and implemented a neighborhood recreation association recycling program.

Lastly, Tyler is a recipient of St. Christopher's John Neasmith Dickinson Memorial Scholarship, and he maintains an active astrophotography blog at *tylerhutchison astrophotography.wordpress.com*

2018 Webmaster Award

Congratulations to **Shawn Loescher** and **Curt Lambert** of the Back Bay Amateur Astronomers (*www.backbayastro.org*) on their selection as the winners of the **2018 Astronomical League Webmaster Award**.

The selection committee evaluated the submitted websites on their content, ease of navigation, and ability to attract people. The Back Bay Amateur Astronomers are fortunate to have such a wonderful and informative website.

Reflector Content Policy (effective July 11, 2018)

This content policy relates to the quarterly *Reflector* magazine and the upcoming *Reflector Monthly* online newsletter. It also applies to any handbook, periodical or website content produced by the Astronomical League. The proposal is based on input from committee members John Goss, Bill Bogardus, Bryan Tobias, John Martin, Mitch Glaze, and Ron Kramer (chair). The input was collected between May 26 and May 29, 2018, and was approved at the League Council meeting on July 11, 2018.

Purpose

Recent questionable articles and advertisements received by *Reflector* staff dictated that a written content policy needs to be created. To date, our policy has been, at best, an arbitrary, unwritten list of what is and is not acceptable. This policy proposal spells out, with clarity, criteria for accepting articles, editorials, advertisements, etc., for the *Reflector*, the *Reflector Monthly*, and any other printed or online materials including social media content.

Content

As the Astronomical League is an astronomical organization, submissions should have astronomy as the primary focus. Submissions concentrating on religion, politics, science fiction, or alternative science (non-Newtonian gravitational theories, flat Earth, ufology, etc.) will not be considered for publication. These subjects can be mentioned in a submission but should not be the primary intent of the piece. Language should be rated G.

Originality

Submissions for publication must be unpublished and be the author's original material. We will no longer accept reprints of articles which have been published earlier. Any supporting material that is included in the author's submission that is not original material must be properly cited and within legal copyright for publication (this includes images).

Review

Submissions will be reviewed for accuracy, relevance, and appropriateness by *Reflector* staff, and may be edited for grammar and formatting to meet *Reflector* standards for publication.

Use

Happy Birthday, RASC!

Your Canadian cousins are having a birthday! The Royal Astronomical Society of Canada (RASC), Canada's counterpart to the AL, celebrates its 150th birthday in 2018. In December 1868, a year after Canada's Confederation, a small group of astronomy enthusiasts met to form the Toronto Astronomy Club. It was a time of increasing public interest and engagement in science. Through the effort and support of amateur and professional astronomers, the club evolved into the RASC. It and its *Journal* became the "voice" of astronomy in Canada. It has grown and matured since then, in parallel with the growth of Canadian astronomy, and Canada itself. Incidentally, surveys show that Canada ranks very highly in astronomical productivity and achievement.

For half a century, the RASC's "guiding light" was Professor Clarence Chant, University of Toronto. Chant also built up his university's astronomy program, which subsequently trained many of Canada's 20th-century astronomers, including me. His contributions to public outreach were remarkable. Among other things, they contributed directly to the founding of the David Dunlap Observatory which, when it opened in 1935, boasted the second-largest telescope in the world.

In 1970, Canadian professional astronomers established their own organization, but the RASC continued to flourish. With members in "centres" (branches) from St. John's in the east, to Victoria in the west, to the Yukon in the north, and with unattached members around the world, it serves thousands of people with a special interest in astronomy. And studies show that the happiest countries (such as the Scandinavian ones) are those whose people tend to join and participate in clubs related to their interests. The RASC is exemplary, in my opinion, in its governance, and the balance between national activities and local ones. The centres are remarkably diverse in their activities and their individual "personalities."

RASC members and centres have contributed to astronomy research, as many amateur astronomers do, by discovering comets and supernovae, and observing meteors, aurorae, occultations, and the Sun. In my research field of variable stars, Canadian observers consistently contribute over 100,000 measurements a year to the American Association of Variable Star Observers (AAVSO).

The RASC has catalyzed and supported the building and operation of public planetariums and observatories, including the ones in my community of Toronto. They are leaders in preserving dark skies through dark sky reserves and by promoting sensible lighting. RASC outreach and communication to schools and the public is exceptional. In 2003, RASC received the prestigious national Michael Smith Award for excellence in science promotion. During International Year of Astronomy 2009, the RASC and its partners organized over 3,700 events, reaching almost two million people face-to-face. The RASC is now the publisher of *SkyNews*, Canada's magazine of astronomy and stargazing, for both astronomy enthusiasts and the public.

The RASC's flagship publication is its annual (since 1907) *Observer's Handbook*. I was delighted to see that the Astronomical League's president John J. Goss had contributed a guest editorial to the 2018 edition—the first year that we have had a USA edition of the *Handbook*. This is surely one more way of drawing our two organizations closer together. The RASC is great at partnering. How about a joint meeting?

The RASC has also done an excellent job of preserving its history and heritage, thanks to historians such as Peter Broughton and Randall Rosenfeld. Check out the "history" page on the RASC website, *rasc.ca*.

I joined the RASC in 1961 and have been proud to serve in many national and local roles over the years, including national president, and editor of the *Observer's Handbook*. Dozens of other astronomer and educator colleagues have cheerfully done likewise, as officers, contributors to the *Journal* or *Handbook*, as speakers at centre meetings, or as partners in outreach activities. We enthusiastically support the work of this voluntary nonprofit organization which, along with its centres and members, has done so much to advance and communicate astronomy, both in Canada and abroad. Happy birthday, RASC!

John R. Percy
Professor Emeritus
Astronomy & Astrophysics and Science Education
University of Toronto
RASC Honorary President 2013–2017
AL Award 1996

Full STEAM Ahead

The Art in ATM

By Peggy Walker

In June 2017, I picked up John Dobson's favorite sidewalk telescope, "Tumbleweed," from Donna Smith of the Sidewalk Astronomers in Burbank, California. John taught amateur telescope making (ATM) classes in the 1990s in San Francisco, and one student made this telescope that John liked so much, he traded his jacket for it. The Sidewalk Astronomers got "her" back and the board agreed to send her out amongst the clubs to keep John's legacy going.

1. John Dobson looking through his favorite sidewalk telescope, Tumbleweed, in San Francisco.

2. John Dobson, founder of the Sidewalk Astronomers, was at the corner of 9th and Irving many nights with Tumbleweed in tow in her wagon.

3. Bob Fies, an amateur astronomer who has a business recoating mirrors, did Tumbleweed's in April 2017.

Kenneth Frank of the Astronomical Society of the Pacific gifted the cost of the realuminizing in April 2017. He contacted Bob Fies from *alcoat.net* who recoated the mirror since he is one of the best in amateur circles.

So Tumbleweed gets to me in Broken Arrow, Oklahoma, and I decided, after seeing her condition, that she needed a total makeover. It became apparent that one couldn't even grab the scope by the wooden base without getting a splinter or two. After removing the mirror and storing it safely in the house, I set to work.

Donna told me John disliked white telescopes, so I chose "cappuccino," a color similar to that already on the tube, "vanilla scone" for the rocker box, and "midnight sky" flat black for the inside of the tube. I chose an oil-base, off-the-shelf black paint for the base, and I had most of the acrylic paints that would be needed for restoring the artwork on the sides.

Tube: The tube had three peeling colors, and the bottom part near the mirror cell had no paint. The ends of the Sonotube were frayed and shedding, and the bits could fall onto the mirror, so I used Elmer's Glue-All on the tube's edge and secured it with paper clips while the glue dried. The tube got four coats of cappuccino paint, which was a feat. Since the rocker box was unmovable on the tube, I put folded cardstock on the inside of the corners of the rocker box, which allowed me to get the paint all the way down on the tube.

Inside of Tube: I used a thick, matte mini–paint roller on a long handle and rolled three layers of paint. The all-wood, handmade spider was painted with a sponge applicator.

Mirror Cell: This got a light sanding, three layers of the black enamel paint, and three coats of polyurethane. I painted Bob Fies's name, business, and date on the bottom of the mirror cell for posterity's sake.

Rocker Box: Fortunately, this was in pretty good condition and only needed minimal sanding. However, there were some gaps where the boards were joined, so I used some wood epoxy to fill these and then re-sanded the box to make a cleaner edge. It was painted with three coats of vanilla scone followed by three coats of polyurethane.

4, 5. All these eyepieces are made with metal pipes, pieces of glass, cardboard, and masking tape.

6. Used Elmer's Glue-All for the end of the frayed tube and held it in place with large paperclips.

7. I painted Bob Fies's name on the bottom of the mirror cell for posterity's sake.

8. It had to be reconstructed.

9. The wood epoxy had to be sanded a few times so that the seams would not be against the natural wood.

10. The front of the base had more delamination of the plywood layers, which led to splintering.

11. The one side that did not have original artwork. It turned out well.

12 With "cappuccino" on the tube, "vanilla scone" on the rocker box, and two fabric end caps, she's good to go.

Altitude Bearings: An amateur astronomer and muscle car–lover at the Casper, Wyoming, ALCon made me aware that the altitude bearings were repurposed harmonic balancers! These were painted with latex paint that had become chipped and scratched and had to be scraped off.

Azimuth Bearing: This was a fun surprise. When the base was removed there was a "Back to the Future" LP from 1985. It is believed the scope was made in the early- to mid-90s, but no one in Sidewalk Astronomers knows for sure.

Wooden Stand: The bottom base for the mount was raw wood with three short legs, and it got four layers of poly, top and bottom, to protect it from moisture.

Base: The layers of the plywood were pulling apart, so I glued them down to prevent anything from breaking off when I sanded. The whole base got sanded, with a light run over the artwork on the sides. The best way to restore the scope properly was to use wood epoxy. I had never worked with it before, and boy does it dry out quickly. It was applied with a putty knife along the edges, sides, and the front, and the altitude bearing supports had to be reconstructed. Black enamel paint was applied after the wood epoxy was sanded, and blue tape had to be used to redefine the edges on the cactus artwork. I think it was airbrushed using a stencil, and so I tried to stay true to the colors and the feel even though I was using a paintbrush. When photos were sent to Donna Smith and the team, Gerard Pardeilhan emailed me and said that I did justice to his artwork that he put on Tumbleweed for John so many years ago! I was so flattered and happy with how it turned out.

The before and after photos are very telling and don't need any more details. However, if you would like to see my daily posts, visit her Facebook page, "Unofficial Tumbleweed."

A few eyepieces, all made in classic ATM style, using metal pipe, glass, cardboard, wood, and tape, accompany Tumbleweed. If your club wants Tumbleweed to visit your club, please contact Donna Smith at *sidewalk astronomers@earthlink.net*. The rules are: 1) no upgrades are to be made, for example, a spotter scope; 2) anything that needs to be repaired gets repaired in the same ATM style; and 3) clubs hosting the scope need to post images of their outreach with her so the Unofficial Tumbleweed Facebook page can stay updated for her followers. There is also a storyboard with before and after images that can be set up at your events so guests can read about her at their leisure.

I appreciated Donna's and the board's trust in my ability to contribute my artistic skills toward this hobby that I love, and my role in keeping John Dobson's memory alive.

13. The inside of the base needed a rough sanding to knock down some raised grain and paint drip marks.

14. This side had more wood epoxy on it and took a couple of sessions to sand down even after painting the black. It had to be done right.

15. This side looked like a stencil or airbrushed piece of art, so redoing it with paint and a brush was challenging when trying to keep the original look.

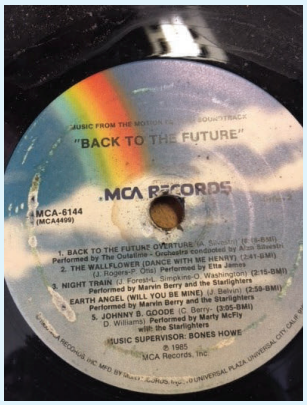
16, 17. You can see that the focuser is on the opposite side of a normal scope's. And there is no spotter scope!

18. Inside the tube with a spider needing a touch-up as well.

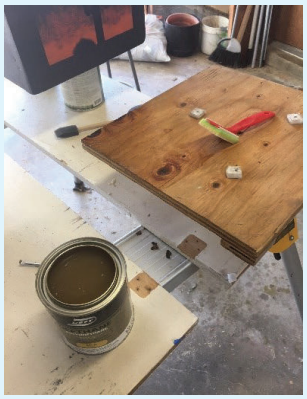
19. Two coats and good as new.

20. The harmonic balancers, a.k.a. altitude bearings, needed the peeling paint removed.

21. Good shot of the original state of the tube with silver paint, sand paint, chipping and peeling, and the mirror cell had no paint on it at all.



22. Felt like this was a time capsule when this was discovered as the azimuth bearing.



23. The raw-wood stand needed some protection before Tumbleweed would go travel to clubs. Four coats of polyurethane top and bottom.

Importantly, the new technique doesn't require any substantial changes to the rest of the fiber optic network and is easy to implement. To keep the frequency stable during transmission, the researchers send the signal through the network to a destination and then reflect it back. The returning signal is used to determine if any changes occurred. After each round trip, any transmitted frequency shift is passively subtracted to exactly compensate for the measured changes.

For every 100 kilometers of fiber, the round trip takes about 1 millisecond. Even though the compensation process happens very quickly, the time on the receiving end can drift during the round trips. To solve this problem, a quartz oscillator at the remote location keeps the time steady between round trips.

The frequency of the quartz oscillator will also eventually drift, so our unique process combines local stabilization with the quartz oscillator for short time lengths, with the longer-greater than round-trip time-stabilization provided by the transmitted stable frequency reference technique," said Baldwin. "This highly stable method for transmitting the frequency reference allows an atomic clock, which cost around two hundred thousand dollars, to be replaced with a system that only costs a few tens of thousand dollars."

Demonstrating long-distance transmission

To demonstrate their method, the researchers began with a type of atomic clock known as a hydrogen maser located at the CSIRO Australia Telescope Compact Array (ATCA). They imprinted the radio frequency reference signal from the maser onto a laser beam that then traveled through a 155-kilometer AARNet fiber and several amplification stages to a second radio telescope, and back again. Once the compensation process began, the reference was picked up by the radio telescope at the other end of the connection.

The researchers used the stable frequency reference to calibrate both telescopes, which were used to examine the same object in space. They found that rather than the stable frequency signal limiting the performance of the telescopes, atmospheric differences between the two locations was the limiting factor. To eliminate atmospheric interference and better understand how the new method improved the telescope performance, the researchers then used just one telescope antenna at the ATCA fitted with two separate receivers to take measurements. This "split antenna" method allowed one receiver stabilized by the hydrogen maser to be compared with the other receiver stabilized using the stable frequency reference that was sent on a 310-kilometer round trip through the fiber.

"Our experiments showed that the transmitted frequency reference was very stable, significantly more stable than the Earth's atmosphere," said Baldwin. "Our approach of exactly replicating the stable frequency signal from one atomic clock performed at least as well as two atomic clocks, which can exhibit slight differences from each other."

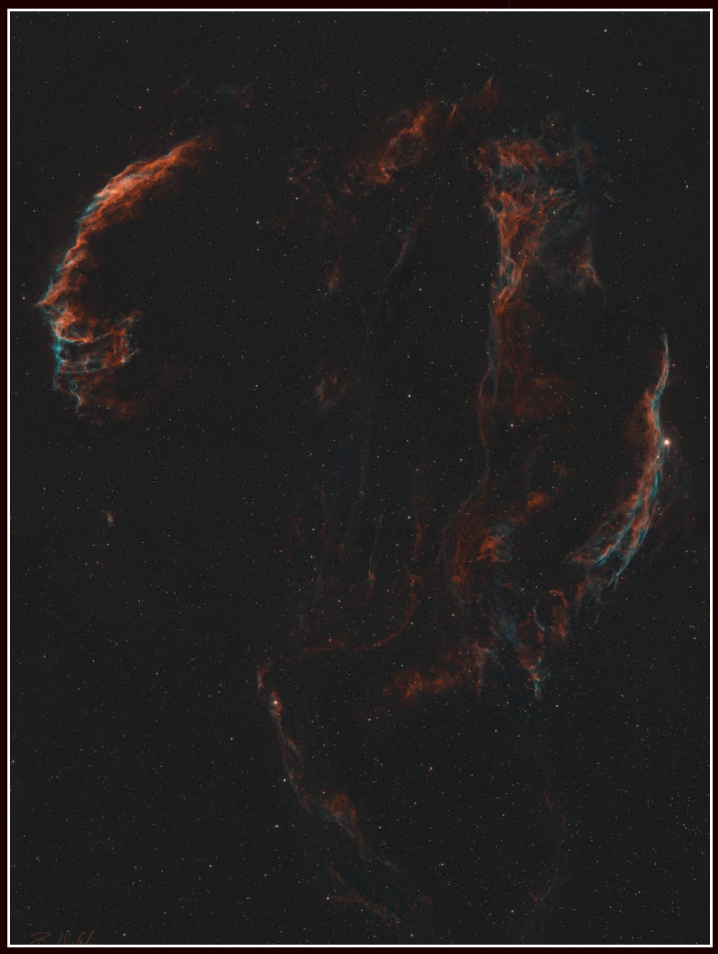
The researchers say that their demonstration shows that the new method is ready for implementation by radio astronomers who want to avoid using multiple atomic clocks across a telescope array. The method can be used over even longer distances by using more amplifiers to boost the signal. This would also allow stable frequency references to be broadcast across a national fiber optic network, where any scientist with access to a telecommunications network could use them.

When atomic clocks were first invented, no one thought that they would provide timing standards that would be used for GPS navigation, for example," said Baldwin. "We hope that in the same way, easy access to frequency standards that are just as stable as those found in a national measurement laboratory will be an enabling technology for many applications that require precise timing and accurate frequency measurements."

Paper: Y. He, K. G. H. Baldwin, B. J. Orr, R. B. Warrington, M. J. Wouters, A. N. Luiten, P. Mirtschin, T. Tzioumis, C. Phillips, J. Stevens, B. Lennon, S. Munting, G. Aben, T. Newlands, T. Rayner, 2018, "Long-distance telecom-fiber transfer of a radio-frequency reference for radio astronomy," Optica, *vol. 5, no. 2, p. 138-146,* doi.org/10.1364/OPTICA.5.000138.

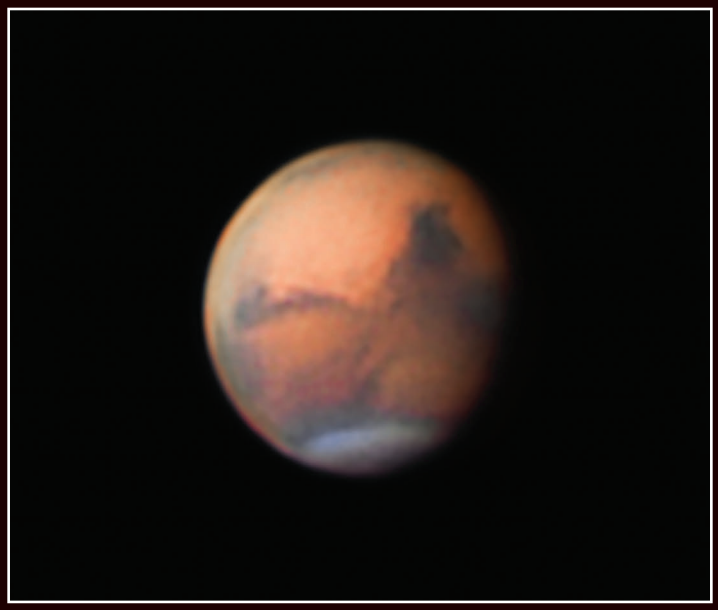
Gallery

TITLE PHOTO: NGC 2244; BRIAN KIMBALL



Robert Huerbsch (Ancient City Astronomy Club) took this image of the Veil Loop with a William Optics GT71 (with 0.8x reducer) and a QHYCCD 163M CMOS camera.

Alan Pryor (Flint River Astronomy Club) took this image of the Lagoon and Trifid nebulae with a Takahashi FSQ-106 with a FLI 16803 CCD camera.



Frederick Steiling (Astronomical Society of Eastern Missouri) took this June 4, 2018, image of Mars with a central meridian of 312.1° from the ASEM observatory in Defiance, Missouri, with a Celestron C14 paired with an ASI174MM CMOS camera and a Tele Vue 2x Powermate.

Dan Crowson (Astronomical Society of Eastern Missouri) took this image of IC 2574, Coddington's Nebula, with an Astro-Tech AT12RCT and a SBIG STF-8300M camera from Dark Sky New Mexico in Animas, New Mexico.

Observing Awards

Editor's Note: Congratulations to all these outstanding astronomical observers! All awards, except for the Herschel 400 and Sky Puppies, 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.

Advanced Binocular Double Star Observing Program
No. 27, Mark Simonson, Everett Astronomical Society

Arp Peculiar Galaxies Northern Observing Program
No. 90-V, Vincent Michael Bournique, Member-at-Large

Arp Peculiar Galaxies Southern Observing Program
No. 16-I, Jack Fitzmier, Atlanta Astronomy Club

Asterism Observing Program
No. 47, Edgar G. Fischer, The Albuquerque Astronomical Society

Beyond Polaris
No. 15, Justin Bolin, Astronomical Society of Kansas City; No. 16, Lauren Rogers, Escambia Amateur Astronomers Association

Binocular Double Star Observing Program
No. 136, Marie Lott, Atlanta Astronomy Club

Binocular Messier Observing Program
No. 1135, Hans de Moor, Member-at-Large; No. 1136, Scott Azmus, Member-at-Large; No. 1137, Eric Geater, Shoals Astronomy Club; No. 1138, Roland Albers, Tri-Valley Stargazers; No. 1139, Eric Pals, Member-at-Large; No. 1140, Richard Beaver, Boise Astronomical Society; No. 1141, Craig Lamison, Houston Astronomical Society

Caldwell Observing Program
Silver Award
No. 249, Len Philpot, Pontchartrain Astronomical Society; No. 250, Larry Farrington, Mt. Shasta Star Gazers
Gold Award
No. 30, Larry Farrington, Mt. Shasta Star Gazers

Carbon Star Observing Program
No. 94, Mark Simonson, Everett Astronomical Society

Comet Observing Program
No. 99, David Whalen, Silver, Atlanta Astronomy Club

Constellation Hunter Observing Program (Northern Skies)
No. 206, Paul Lennos, Member-at-Large; No 207, Chad Ruhl, Richland Astronomical Society

Dark Nebulae Observing Program
No. 28, Dan Crowson, Astronomical Society of Eastern Missouri

Dark Sky Advocate Observing Award
No. 12, Jim Ketchum, Astronomical Society of Kansas City

Deep Sky Binocular Observing Program
No. 396, Laura Hintz-Keller, Indiana Astronomical Society; No. 397, Preston Pendergraft, Member-at-Large; No. 398, Alfred Schovanez, Astronomical Society of Eastern Missouri; No. 399, Jeff Oaster, Delaware Valley Amateur Astronomers

Double Star Observing Program
No. 609, Alan Snook, Member-At-Large; No. 610, Nancy Rauschenberg, Minnesota Astronomical Society; No. 611, Forrest Smith, Baton Rouge Astronomical Society; No. 612, Alan Scott, The Albuquerque Astronomical Society

Flat Galaxy Observing Program
No. 33, Dan Crowson, Honorary, Astronomical Society of Eastern Missouri

Globular Cluster Observing Program
No. 313-I, John Sikora, Member-at-Large

Herschel 400 Observing Program
No 587, Nancy Rauschenberg, Minnesota Astronomical Society; No. 588, Bruce Bookout, Colorado Springs Astronomical Society; No. 589, Mike Neal, Echo Ridge Astronomical Society; No. 590, Linda Hoffmeister, Olympic Astronomical Society; No. 591, Chuck Stewart, Rose City Astronomers; No. 592, Jonathan Poppele, Minnesota Astronomical Society; No. 593, Joe Timmerman, Minnesota Astronomical Society; No. 594, Joe Castor, Kansas Astronomical Observers

Hydrogen Alpha Solar Observing Program
No. 41, Rodney R. Pendergraft, St. Louis Astronomical Society; No. 42, Will Young, Astronomical Society of Southeast Texas

Lunar Observing Program
No. 1030, DeWayne Carver, Member-at-Large; No. 1031, Lynda Schweikert, Iowa County Astronomers; No. 1032, Chad D. Ruhl, Richland Astronomical Society

Lunar II Observing Program
No. 85, David M. Douglass, East Valley Astronomy Club; No. 86, Robert Scott, Island County Astronomical Society; No. 87, John T. Varn, Cedar Amateur Astronomers; No. 88, Kim Balliet, Richland Astronomical Society

Master Observer Award
Observer Award
Paul Lennous, Member-at-Large; Larry M. Elsom, Member-at-Large
Master Observer Award
No. 209, Coy Wagoner, Baton Rouge Astronomical Society; No. 210, Lisa Wentzel, Twin City Amateur Astronomers; No. 211, William T. Conner, Indiana Astronomical Society; No. 212, Nancy Rauschenberg, Minnesota Astronomical Society; No. 214, Bruce P. Bookout, Colorado Springs Astronomical Society; No. 215, Jonathan Poppele, Minnesota Astronomical Society
Advanced Observer Award
Steve Boerner, Member-at-Large
Master Observer—Silver Award
David Whalen, Atlanta Astronomy Club; Jeff Hoffmeister, Olympic Astronomical Society
Master Binocular Observer Award
Vincent Michael Bournique, Member-at-Large; Denise Terpstra, Member-at-Large

Messier Observing Program
No. 2737, Darin Templet, Honorary, Rio Rancho Astronomical Society; No. 2743, Janet Rush, Honorary, Delaware Valley Amateur Astronomers; No. 2756, Marilyn Perry, Honorary, Member-at-Large; No. 2783, Dodie Reagan, Regular, Texas Astronomical Society of Dallas; No. 2784, Yu-Hang Kuo, Honorary, Seattle Astronomical Society; No. 2785, Todd Hansen, Honorary, Tucson Amateur Astronomy Association; No. 2786, Marilyn Sameh, Honorary, Wabash Valley Astronomical Society; No. 2787, Mike Reitmajer, Regular, Rose City Astronomers; No. 2788, Hal Bidlack, Honorary, Colorado Springs Astronomical Society; No. 2789, Bob Nolen, Honorary, Shreveport-Bossier Astronomical Society; No. 2790, Scott Lee, Honorary, Boise Astronomical Society

NEO Observing Program
No. 16, Jeff Haidet, Intermediate, Toledo Astronomical Association; No. 17, Jeff Haidet, Advanced, Toledo Astronomical Association

Open Cluster Observing Program
No. 82 Advanced, Dan Crowson, Astronomical Society of Eastern Missouri

Outreach Observing Award
No. 105-S, Marilyn Unruh, Prescott Astronomy Club; No. 166-S, Elizabeth Brown, Astronomical Society of Kansas City; No. 495-M, Terry N. Trees, Amateur Astronomers Association of Pittsburgh; No. 497-M, John W. Johnson, Omaha Astronomical Society; No. 759-M, Steve Goldberg, Houston Astronomical Society; No. 769-S, David Downs, The Albuquerque Astronomical Society; No. 795-M, Connie Haviland, Fort Bend Astronomy Club; No. 832-S, Ken Lim, Fort Bend Astronomy Club; No. 857-M, Dave Komar, Northern Virginia Astronomy Club; No. 859-S, John Cavouti, Fort Bend Astronomy Club; No. 860-S, Christophe Caille, Fort Bend Astronomy Club; No. 894-S, James King, Houston Astronomical Society; No. 919-M, Keith Krumm, Seattle Astronomical Society; No. 994-S, Douglas Tilley, Prescott Astronomy Club; No. 1003-S, Abigail Bollenbach, Bartlesville Astronomical Society; No. 1004-O, Don Reed, Von Braun Astronomical Society; No. 1005-O, Benjamin N. Boyd, Von Braun Astronomical Society; No. 1006-O, Mike Reitmajer, Rose City Astronomers; No. 1007-O, Jon Bearscove, Seattle Astronomical Society; No. 1008-O, Gianna Neckel, Flint River Astronomy Club; No. 1009-O, Scott Cadwallader, Baton Rouge Astronomical Society; No. 1010-O David M. Douglass, East Valley Astronomy Club; No. 1011-O, Krista Dison, Baton Rouge Astronomical Society; No. 1012-O,

Jason Hoover, Prescott Astronomy Club; No. 1013-O, Jack Szelka, Prescott Astronomy Club; No. 1014-O, Andy Flowers, Tallahassee Astronomical Society; No. 1015-S, Ron Mosher, Everett Astronomical Society; No. 1016-S, Louis S. Berman, Delaware Valley Amateur Astronomers; No. 1017-O, Stephen L. Snider, The Albuquerque Astronomical Society; No. 1018-O, Wayne Wooten, Escambia Amateur Astronomers' Association; No. 1019-O, Dewey Barker, Escambia Amateur Astronomers' Association; No. 1020-O, John Arnold, Escambia Amateur Astronomers' Association; No. 1021-O, Ed Magowan, Escambia Amateur Astronomers' Association; No. 1022-O, Jon Minnick, Seattle Astronomical Society; No. 1023-O, Joanne Hachtel, Popular Astronomy Club; No. 1024-M, Richard M. Bryant, Jr., Bartlesville Astronomical Society

Sketching Observing Award

No. 26, Vincent Michael Bournique, Member-at-Large; No. 27, David Whalen, Atlanta Astronomy Club; No. 28, Bob Scott, Island County Astronomical Society

Solar System Observing Program

No. 114, William Bogardus, Amateur Observers' Society of New York; No. 115-B, Vincent Michael Bournique, Member-at-Large; No. 116, Ron Ziss, Naperville Astronomical Association; No. 117-B, Denise Terpstra, Member-at-Large; No. 118, Vince Giovannone, Member-at-Large; No. 119-B, Steve Boerner, Member-at-Large; No. 120, Jean Napp, Iowa County Astronomers; No. 121, Stephen L. Snider, The Albuquerque Astronomical Society; No. 122, Brad Payne, Northern Virginia Astronomy Club; No. 123, Nina Chevalier, San Antonio League of Sidewalk Astronomers

Southern Skies Binocular Observing Program

No. 101, Melody Hamilton, Member-at-Large; No. 102, John L. Goar, Olympic Astronomical Society

Southern Sky Telescopic Observing Program

No. 58, John Wagoner, Texas Astronomical Society of Dallas

Stellar Evolution Observing Program

No. 47, Daniel Otte, Basic, Southern Oregon Skywatchers; No. 48, W. Maynard Pittendreigh, Basic, Brevard Astronomical Society; No. 49, Jonathan L. Schuchardt, Basic, Rio Rancho Astronomical Society; No. 50, John R. "Sean" Sayers, Basic, Member-at-Large; No. 51, Ian Hewitt, Basic, Raleigh Astronomy Club; No. 52, Rodney R. Rynearson, Basic, St. Louis Astronomical Society; No. 53, Edgar G. Fischer, Basic, The Albuquerque Astronomical Society; No. 54, Dan Posey, Basic, Hill Country Astronomers; No. 55, Pam Lubkans, Basic, Member-at-Large; No. 56, Lisa Judd, Basic, Denver Astronomical Society; No. 57, Joe Timmerman, Basic, Minnesota Astronomical Society; No. 58, Lisa Wentzel, Basic, Twin City Amateur Astronomers; No. 59, Cliff Mygatt, Basic, Olympic Astronomical Society; No. 60, Richard Francini, Basic, Neville Public Museum Astronomical Society; No. 61, Nina Chevalier, Basic, San Antonio League of Sidewalk Astronomers

Two in the View Observing Program

No. 30, Kevin C. Carr, Minnesota Astronomical Society; No. 31, Nina Chevalier, San Antonio League of Sidewalk Astronomers; No. 32, Alex McConahay, Pomona Valley Amateur Astronomers

Universe Sampler Observing Program

No. 134, Pamela Lowe, Naked-Eye, Boise Astronomical Society

Urban Observing Program

No. 193, Vincent Michael Bournique, Member-at-Large

Coming Events

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

September 1
Gateway to Space 2018: Destination Moon
Saint Louis, Missouri
www.bit.ly/2uVtwx9

September 5–9
Acadia Night Sky Festival
Mount Desert Island, Maine
www.acadianightskyfestival.com

September 6–8
Great Basin National Park Astronomy Festival
Baker, Nevada
www.nps.gov/grba/planyourvisit/astronomy-festival.htm

September 6–9
Great Lakes Star Gaze
Gladwin, Michigan
www.greatlakesstargaze.com

September 6–10
Iowa Star Party
Whiterock Conservancy, Coon Rapids, Iowa
www.iowastarparty.com

September 7–9
Idaho Star Party
Bruneau State Park, Idaho
www.isp.boiseastro.org

September 14–15
Astronomy at the Beach
Island Lake State Recreation Area, Brighton, Michigan
www.glaac.org/astronomy-at-the-beach

September 29
Virginia Association of Astronomical Societies (VAAS) Convention
Randolph-Macon College, Ashland, Virginia
richastro.org/index.php/vaas-2018

September 30–Oct. 7
Peach State Star Gaze
Deerlick Astronomy Village, Georgia
atlantaastronomy.org/pssg

October 4–6
Illinois Dark Skies Star Party
Jim Edgar Panther Creek State Fish and Wildlife Area, Illinois
www.sas-sky.org

October 4–7
Heart of America Star Party
Butler, Missouri
askc.org/events/hoasp

October 4–8
Hidden Hollow Star Party
Hidden Hollow Camp, Ohio
wro.org/?page_id=7

October 5–6
Kopernik AstroFest
Vestal, New York
kopernikastro.org/astrofest

October 5–7
Chiefland Star Party
Chiefland, Florida
chieflandstarpartygroup.com

October 6–13
OzSky Star Safari, a.k.a. the Deepest South Texas Star Party
Coonabarabran, New South Wales, Australia
www.OzSky.org
Attendance is extremely limited

October 6–14
Okie-Tex Star Party
Kenton, Oklahoma
Oklahoma City Astronomy Club
www.okie-tex.com

October 8–14
Staunton River Star Party
Scottsburg, Virginia
www.stauntonriver-starparty.org

October 9–13
Enchanted Skies Star Party
Socorro, New Mexico
www.enchantedskies.org/essp

October 12–14
Bays Mountain StarFest
Bays Mountain Park, Kingsport, Tennessee
www.baysmountain.com/astronomy/astronomy-club/?GTTabs=4

November 1–4
Nightfall
Borrego Springs, California
nightfallstarparty.com

November 2–4
StarFest 2018
Custer Institute, Southold, New York
custerobservatory.org

November 5–10
Eldorado Star Party
X-Bar Ranch, Eldorado, Texas
www.eldoradostarparty.org

November 6–11
Deep South Regional Star Gaze
Norwood, Louisiana
www.stargazing.net/dsrsg

The Astronomical League is now 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*.

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Limited Quantities–Order Early
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Astronomical League full color cloth patch (3" diameter)
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Bandana
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"Guide to the Stars" 16" Planisphere
$21 plus
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Globular Clusters
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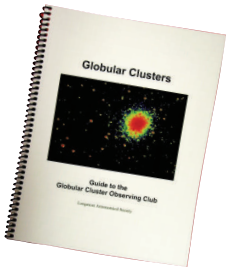

Meteors—*A Guide to the Meteors Observing Program*
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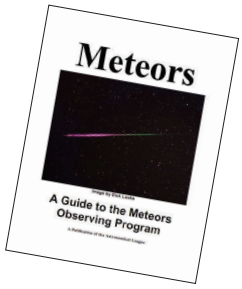
$4 S&H



Sky Puppies Observing Manual–
For the Sky Puppy Observers Club
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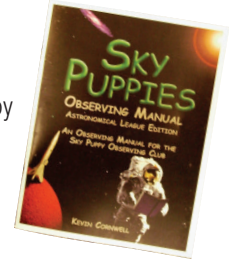
Sale price $8
plus $4 S&H



Planetary Nebulae
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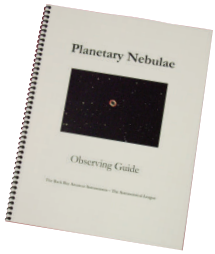

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RASC Explore the Universe Guide
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$4.50 S&H

Observe Eclipses
Regularly $18,
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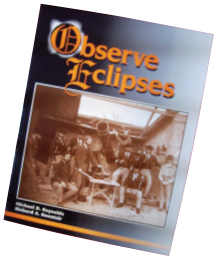

Universe Sampler
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$3 S&H

Astronomy for Educators Handbook
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Planning Guide
5.5" x 7.25"
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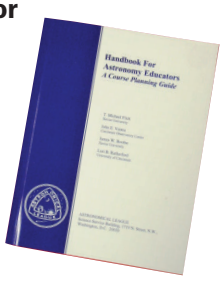
Sale price $6
plus $2 S&H



Observe the Herschel Objects
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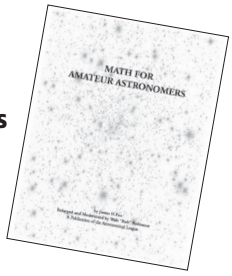

Carbon Stars
A guide to the Carbon Star Observing Club
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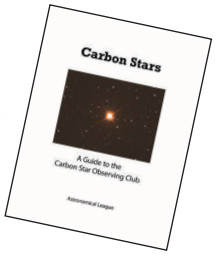

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