

THE DELAWARE VALLEY

amateur ASTRONOMER



sharing the wonder and science of astronomy

A New Year, A New Newsletter!

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Well, 2020 has been real...something. Here's to 2021!

This year, we're trying something new with this Newsletter. We have amended the By-Laws (see p. 3 for detailed election results) to spin off the newsletter responsibilities from the Secretary position. Now, the Newsletter will be produced by an all-new Newsletter Committee, currently composed of Jeremy Carlo, George Keighton, Tom Nolasco, Dana Priesing, and Janet Rush.

We hope this will bring more variety and fresh ideas into the newsletter production process, and also get more folks involved in the club! Producing the Newsletter is a lot of work each month, but it's a labor of love, although having more hands to share the work will be welcome! Some of us are past Editors, and some of us are new to the position; we're all looking forward to a new year (and for many reasons besides just the newsletter!).

We all owe Jan Rush a great debt of gratitude for her great work with the newsletter over the past three years; she's left some enormous shoes to fill, but thankfully she'll be continuing on as a member of our editorial team!

If you would be interested in joining us on the Newsletter Committee, just drop us a line at newsletter@dva.org — we'd love to have you on board, regardless of your experience level!

In the meantime, we're proud to present the first newsletter of 2021, and are looking forward to the new year! Hopefully with the COVID-9 vaccine on the way, we'll be able to resume some level of normalcy over the coming year. Until then, we will continue as we have been, with socially distant star parties and virtual monthly meetings you can enjoy from the comfort of home.

— Jeremy Carlo (lead editor for this issue), for the DVAA Newsletter Committee

Mentorship Opportunity for Beginning and Intermediate Observers

Would you be interested in one-on-one observing mentoring via Zoom or video chat? If you decide to participate, you'll be assigned a mentor based upon your interest and experience. As a first step, please complete the online survey. The survey will close on January 7.

[Mentoring Survey](#)

PLAN ON IT!

Jan. 9-10 and 16-17 Dark Sky Observing. Check groups.io for updates (New Moon Jan. 13).

Jan. 10 (3:30pm) Women of DVAA Meet-and-Greet Zoom Meeting. [More info.](#)

Jan. 22 (7:30 pm) Monthly Meeting via Zoom (members) and YouTube (public). Featured presenter: John Conrad, NASA/JPL Solar System Ambassador. Publicly available on [YouTube](#). Members, check your email for the Zoom meeting link.

Feb. 6-7 and 13-14 Dark Sky Observing. Check groups.io for updates (New Moon Feb. 11).

Feb. 26 (7:30 pm) Monthly Meeting via Zoom (members) and YouTube (public). Featured presenter: Dr. Joleen Carlberg, Space Telescope Science Institute (STScI). Watch for an email from Program Chair Jeremy Carlo with the meeting links.

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Dave Mitsky's Celestial Calendar can be found at www.dvaa.org, under the "Observing" menu

2020 Sucked; What's Up Ahead?

Harold Goldner [email](#)

Sometimes I berate myself for not having taken up the hobby of cloud watching. I would have been able to spend long nights gazing at the objects of my affection, even in a downpour or even an electrical storm, if so motivated. I wouldn't have had to spend a dime on equipment other than appropriate outdoor wear. Like the rest of our members, however, I decided that it was what lay beyond the clouds that intrigued me, and instead became an amateur astronomer, such that looking at clouds from any side did not yield an illusion, notwithstanding Joni Mitchell's observations, but rather just an impediment to a good time.

And 2020 was so very awful for so very many reasons, some of which will no doubt leak into 2021, at least until widespread vaccination is commonplace and the pandemic has ebbed sufficiently that people can actually joke about it and nobody will say, "too soon!" Many of us have lost loved ones; lost jobs; lost income; lost that which was dear to us, and yet here goes the earth on yet another trip around the sun as though nothing were awry.

Let's look at what 2021 offers us as amateur astronomers. It's a tasty smorgasbord.

January 2nd and 3rd will bring the Quadrantid Meteor Shower, unfortunately only days after a full moon.

We will all be on the edge of our seats on February 18th to see whether Perseverance nails the dismount on Mars at Jezero Crater. (At least that won't be clouded out). Within a few weeks China's Tianwen-1 will attempt a Mars landing at Utopia Planitia.

Venus will be at greatest eastern elongation on March 20th, giving all of us amateur astronomers the chance to tell everybody who asks us that, "no, that's not an airplane stuck in the air, nor is it a flying saucer."

The Lyrids are April 22nd and 23rd, just a few days before the full moon (of course) and the Eta Aquarids will be May 6th and 7th, also just prior to the next full moon. (Don't these meteors think about this stuff in advance?)

June 10th will see a partial solar eclipse in the Greater Philadelphia area, which will be annular up in Canada, which, of course makes sense, because the Canadian dollar isn't worth what the American dollar is.

Venus and Mars will be only 29 minutes apart on July 13th, not as spectacular as the Great Conjunction of December 2020 might have been if

we'd actually been able to see it, but impressive, nonetheless.

The Perseids, one of my favorite meteor showers, will peak on August 12th and 13th less than a week after a new moon. That might just be the time to visit Cherry Springs State Park.

On October 16th, NASA will launch "Lucy" to visit the Trojan asteroids of Jupiter, and a few weeks later, fingers crossed, the James Webb Telescope will finally leave Planet Earth.

Uranus is at opposition on November 5th, and the Leonids follow shortly behind on the 17th and 18th of November just in time for, you guessed it, another full moon, although this time accompanied by a partial lunar eclipse.

There will be a total solar eclipse on December 4th visible only the extreme southern hemisphere, but by then, if the stars are aligned, we will be meeting in person at Radnor, returning to Minella's Main Line Diner after meetings, sharing our eyepieces at Valley Forge Model Airplane Field, and doing outreach where we let utter strangers actually look through our telescopes.



Next Monthly Meeting: January 22, 2021

NASA Infrared Platforms: Seeing better across space and time

John Conrad, NASA/JPL Solar System Ambassador

Why is infrared astronomy so important, and what instruments do we use?

SOFIA – an amazing current airborne platform for infrared astronomy – is presented: description, operations, results.

The Space Telescopes – Spitzer (past), Hubble (present), and James Webb (future) – are summarized with regard to major features and accomplishments / potential.

John Conrad is a retired aeronautical engineer who worked with the Air Force and NASA. He has given several excellent presentations to the DVAA in recent years, and this is sure to be a great talk!



DVAA Virtual Meeting - January 22, 2021 at 7:30 PM (sign-on begins at 7:00pm).

- ♦ DVAA Members via Zoom (check your email for the link)
- ♦ Members of the public can watch the livestream on [YouTube](#)

Welcome New DVAA Members!

Katie Daisey **Herbert Garvin**
Korinne Jacob **Martin Jones**
David McDugall **Sarah Newton**
Anika Verma **Monica Verma**
Shishir Verma **Taara Verma**

We welcome all new members to enjoy the most our club has to offer by participating in DVAA activities. You are encouraged to ask questions and pursue your interests in astronomy through the club.

We suggest that new members attend our observing events and special interest group meetings, or volunteer to help with an outreach event or committee. Participation can advance your skills and enjoyment of the hobby and help you get to know your fellow members. New members are entitled to all benefits of membership.

Brian Lee
Welcoming Committee Chair
welcoming@dvaa.org



DVAA Board & Committee Chairs

Title	Name	Email
President	Harold Goldner	president@dvaa.org
Vice-President	Jan Rush	veep@dvaa.org
Secretary	Mike Tucker	secretary@dvaa.org
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Light Pollution	Barry Johnson	lpollution@dvaa.org
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Women of DVAA	Jan Rush	women@dvaa.org

Newsletter Editorial Committee: Jeremy Carlo, George Keighton, Tom Nolasco, Dana Priesing, and Jan Rush.

Mark Your Calendars!

Election Results

At the 2020 Annual Business Meeting on December 13, elections were held for DVAA Board Positions for 2021.

The following officers were elected:

President: Harold Goldner
Vice President: Jan Rush
Secretary: Mike Tucker
Treasurer: Lou Berman
Members-at-Large (3): Roy Patton, Tracey Trapuzzano, and Barry Johnson

The number of Members-at-Large has been increased from one to three, as per an earlier By-Laws Amendment.

The proposed By-Laws amendment to form a Newsletter Committee was also accepted (see note on p. 1).

Congratulations to all elected officers, and thank you to all who ran!

Consistent with recommendations from Governor Wolf and the Centers for Disease Control, some live DVAA public events have been cancelled or postponed. Monthly meetings are being held via Zoom and livestreamed via YouTube. Check the website (www.dvaa.org) for updates.

Upcoming Monthly Meetings

Jan. 22, 2020 (Friday): Featured Speaker: John Conrad, NASA/JPL Solar System Ambassador: "NASA Infrared Platforms" (see p. 2).

The regular monthly meeting will be livestreamed. Watch your email for sign-on directions.

Meeting dates for 2021: (all Friday evenings): Jan. 22, Feb. 26, Mar. 26, Apr. 23, May 21, June 25, July 23, Aug. 20, Sept. 17, Oct. 15, Nov. 19, and Dec. 17.

2021 Public Star Parties

DVAA public star parties are held at Valley Forge National Historical Park on the Model Airplane Field, and will resume in March 2021. ([Google Maps](#)). **Weather Hotline: 484-367-5278.**

Follow the DVAA on Facebook!



DVAA [Facebook](#) group
DVAA [Photo Enthusiasts](#)

Al's Observing Tips

Where Do I Start?

Al Lamperti [email](#)



Astronomy has an infinite number of items to hold any a casual or avid interest. The night sky offers so much to us that it can be overwhelming when trying to figure out what to start observing. Whether you are embarking on naked eye, binocular or telescopic observing, an ordered game plan lends order to the apparent chaos. Initially you may choose to concentrate on one or two constellations on any particular evening. Perusing an atlas or sky charts will familiarize you with the naked eye, binocular and telescopic objects that can be seen.

Some amateurs invest a fair amount of prep time prior to each observing session. Making a list of objects you plan to observe is quite helpful. The list may include size and magnification of the object as well as the page of the atlas where you can find it quickly. You may also de-

termine what order to view those objects, as you can star hop easily from one to another. The dimensions and brightness of each object may give you a sense of perspective as to how large and visible it might be. This general game plan holds true if you are tackling the Messier list of objects with your binoculars or telescope. If the night is exceptionally clear, you may wish to observe those objects with a lower declination and save the others near the zenith for later. You can mount your initial attack on those objects at or near the meridian, i.e., the highest point the object gets as it rises from the East and before it sets in the West. Thereafter you can lay in ambush for the objects as they rise from the East and approach the meridian.

For those with an interest in lunar observing, the waxing Moon reveals more

of itself each evening as the month goes by. Looking at an atlas of the moon, such as the one by Rukl, will give you a sense of the various features, their names and other geological information. You can choose those features near the terminator (where the light meets the dark) as it is there that, because the sun angle is the lowest and the shadows the longest, we see the best relief detail of a crater, mountain range, rille or lava basin.

The time under a dark sky is precious, so why not organize your observing plan prior to your session. It will save you time and minimize frustration. Regardless of how or what you observe, you will enjoy the splendors the sky affords us.



(above, both images) Photography by Mitch Berger. (above left) The Great Conjunction of Jupiter and Saturn, imaged from a partly cloudy sky above the Quarry Center Giant in Havertown on December 27, 2020: "A Match Made in Heaven ... the Gas Giants over Giant Gas!" (above right) Close-up of Jupiter and Saturn from the same evening.

Telescope Rental Experience

Rick Schumann



Joining DVAA fulfilled one of my true interests in life – Space. I don't possess the intellect or skills to have made it my career (believe me, If I had, I would). Instead, growing up I have always followed major milestones as they were attempted and/or achieved when it related to space.

With the help of organizations like DVAA, reading articles and watching videos found on the Internet, a person, much like myself, can actually achieve a certain level of "hands-on" involvement that was not easily attainable during the past 50 years.

My goal in joining DVAA, besides listening to guest and/or member speakers, who have a higher learning experience of all things Space, was to get more personally exposed to learning about amateur astronomy and eventually be able to maybe purchase my own telescope.

One of DVAA's features is their Telescope Rental Program, which actually drew me to them in the first place.

Their rental program does not focus on a pool of like-telescopes only to rent out for the sole purpose of raising revenue for the club. Instead, they have a variety of telescopes for rent (all at the same small, monthly fee) in order to provide the budding astronomer an assortment of telescopes to choose from.

This not only helps draw in new members (like it did me), but it also affords those who may have an interest in possibly owning a telescope - but haven't a clue which 'kind' of telescopes would suit their needs - the chance to try them out.

The funny thing about purchasing a telescope, if you're clueless like I am, you might have better odds winning it big at a blackjack table in Atlantic City or Las Vegas then deciding on which type of telescope and/or accessories to purchase the first time -AND- still end up being happy with your decision.

There is a large range of pricing and capabilities when purchasing a telescope that I've learned about since being a member of DVAA (actually, 'made aware of' would be more accurate – I still have a lot to learn).

For instance, being able to rent a certain type of telescope for a month at a time from the club, you're able to experience, first hand, the features and capabilities of that specific type of telescope before going out and buying it.

It provides an invaluable opportunity. There is probably nothing worse than diving in head first, maybe unknowingly, and purchasing your first telescope. Doing so might turn out to not provide the expected experience you were hoping for. Then, possibly because of that, you loose interest and your first telescope ends up just sitting there. Kind of like my universal gym, which over the years, has become more like a universal clothes hanging apparatus.

My first telescope I rented from DVAA, after only being a member for 2 months, was the "[Celestron Nexstar 5 SE](#)". Tripod mounted, motor driven using the 'NextStar' built-in tracking motor & software, I was able to experience a variety of technologies that were discussed here-and-there in the 2 meetings since I joined.

One of the most personally fulfilling moment for me was the first time I saw Saturn, its rings & moons through this one telescope.

We've all seen pictures of Saturn, it's rings and moon close up from all of the fly-by photographs seen online, in the news or magazines and TV. But to see it for the first time through a telescope (BTW, I'm 65 years old) made a profound impact on me. Don't know why. Can't explain it. However, I felt as though I finally knew where my place on Earth was relative to Saturn. And that's just weird.

I could see for the first time, with

my own eyes, how Saturn was actually positioned/oriented – on a slight tilt – relative to where I was standing on Earth. Can't explain why I had that sensation, but for whatever reason, it was truly impactful to me – and I have none other than DVAA to thank for that experience. Then it drifted out of my field of view and I had to go chase it down repeatedly. That too – how quickly it moves across the sky - was something that I never expected. Another life experience to chalk up.

That little annoyance of Saturn constantly moving out of my field of view drove me to setting up the included motor. After which, I was able to enjoy viewing Saturn while it stayed relatively still in my field of view.

My second telescope I rented from DVAA was a desktop model that was completely manually operated.

Although the experience was not as satisfying for me as when I had rented the Celestron, it was really good for viewing the moon. I was satisfied to site the telescope to the leading edge of the moon and just sit back and allow moon slowly drift across the field of view.

The desktop model allowed me to easily find the moon, but for planets or deep space objects I found it to be frustrating to use.

However, the DVAA Telescope Rental plan allowed me to see, firsthand, what scope and features matched my interests – even if I didn't know what my interests were at the time. The rental program also allowed me to do a great, side-by-side, unscientific comparison of different types of telescopes by allowing me to simply 'kick the tires' or 'take them out for a spin' WITHOUT pouring a lot of money into having to purchase a telescope without the minimal experiences I obtained.

I HIGHLY recommend taking advantage of the club's feature available to all its members.

Check Your Sky's Quality with Orion!

David Prosper

This article is distributed by NASA Night Sky Network

The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit night-sky.jpl.nasa.gov to find local clubs, events, and more!



Have you ever wondered how many stars you can see at night? From a perfect dark sky location, free from any light pollution, a person with excellent vision may observe a few thousand stars in the sky at one time! Sadly, most people don't enjoy pristine dark skies – and knowing your sky's brightness will help you navigate the night sky.

The brightness of planets and stars is measured in terms of **apparent magnitude**, or how bright they appear from Earth. Most visible stars range in brightness from 1st to 6th magnitude, with the lower number being brighter. A star at magnitude 1 appears 100 times brighter than a star at magnitude 6. A few stars and planets shine even brighter than first magnitude, like brilliant Sirius at -1.46 magnitude, or Venus, which can shine

brighter than -4 magnitude! Very bright planets and stars can still be seen from bright cities with lots of light pollution. Given perfect skies, an observer may be able to see stars as dim as 6.5 magnitude, but such fantastic conditions are very rare; in much of the world, human-made light pollution drastically limits what people can see at night.

Your sky's **limiting magnitude** is, simply enough, the measure of the dimmest stars you can see when looking straight up. So, if the dimmest star you can see from your backyard is magnitude 5, then your limiting magnitude is 5. Easy, right? But why would you want to know your limiting magnitude? It can help you plan your observing! For example, if you have a bright sky and your limiting magnitude is at 3, watching a meteor shower or looking for dimmer stars and objects may be a wasted effort. But if your sky is dark and the limit is 5, you should be able to see meteors and the Milky Way. Knowing this figure can help you measure light pollution in your area and determine if it's getting better or worse over time. And regardless of location, be it backyard, balcony, or dark sky park, light pollution is a concern to all stargazers!

How do you figure out the limiting magnitude in your area? While you can use smartphone apps or dedicated devices like a Sky Quality Meter, you can also use your own eyes and charts of bright constellations! The Night Sky Network offers a free printable Dark Sky Wheel, featuring the stars of Orion on one side and Scorpius on the other, here: bit.ly/darkskywheel. Each wheel contains six "wedges" showing the stars of the constellation, limited from 1-6 magnitude. Find the wedge containing the faintest stars you can see from your area; you now know your limiting magnitude! For maximum accuracy, use the wheel when the constellation is high in the sky well after sunset. Compare the difference when the Moon is at full phase, versus new. Before you start, let your eyes adjust for twenty minutes to ensure your night vision is at its best. A red light can help preserve your night vision while comparing stars in the printout.

Did you have fun? Contribute to science with monthly observing programs from Globe at Night's website (globeatnight.org), and check out the latest NASA's science on the stars you can - and can't - see, at nasa.gov.



The Dark Sky Wheel, showing the constellation Orion at six different limiting magnitudes (right), and a photo of Orion (left). What is the limiting magnitude of the photo? For most observing locations, the Orion side works best on evenings from January-March, and the Scorpius side from June-August.

The December Monthly Meeting

Jeremy P. Carlo ([email](#))



The December 2020 meeting was opened by President Harold Goldner. Harold started by thanking all those who have helped out over the past year in making DVAA activities and events successful despite the challenges of 2020. These included Lou Berman, Andrew Hitchner, Jeremy Carlo, Joe Lamb, Brian Lee, Barry Johnson, Al Lamperti, Bill McGeeney, Roy Patton, Nate Prentice, Mike Tucker, Lou Varvarezis, and especially Jan Rush, who wears many hats in our organization! Harold announced the new Newsletter Editorial Board, consisting of Jeremy Carlo, George Keighton, Tom Nolasco, Dana Priesing, and Jan Rush. Harold also welcomed two new members, and reminded attendees of the upcoming Annual Business Meeting on December 13.

Moving on to committee reports, Treasurer Lou Berman reminded members that the time to renew dues is fast approaching, and demonstrated how to renew using the DVAA website. Jan Rush (wearing yet another hat!) reported that the recent online Auction went very well, and that most items have already been paid for and transferred to their new owner.

Next, Observing Chair Andrew Hitchner gave his observing report for December, on the very timely subject of astronomical conjunctions. A conjunction occurs when two objects have the same right ascension or ecliptic longitude. The terminology gets quite complex, but loosely speaking a conjunction occurs when objects pass very close to one another in the sky. This could involve two solar system objects, or a solar system object and a more distant fixed object. Andrew showed an image of a conjunction of the Moon, Venus, and Jupiter, as an example.

Andrew gave a brief overview of celestial coordinates. Right ascension and Declination are essentially like Longitude and Latitude on the sky. This coordinate system is fixed to the earth's rotational axis. There is also a separate ecliptic coordinate system, which is affixed to the earth's orbital axis. Since the earth's rotation axis is inclined 23 degrees with respect to its orbit, so too are these coordinate systems. The ecliptic coordinate system is defined by the so-called ecliptic, in a way the "equator" of the ecliptic coor-

dinat system, which corresponds to the earth's orbital plane, and roughly to the sun's equatorial plane. Most solar system objects (the large ones, at least) follow paths through the sky which roughly move along the ecliptic. Thus this is where most of the "action" (including solar and lunar eclipses, hence the name) occur.

Andrew then talked about some specific examples of conjunctions, and went through some additional terminology, including the distinction between superior and inferior conjunctions, and the interesting "triple conjunctions," in which an object passes another, then falls behind, and then passes again, making for three close approaches! Of course, the timeliness of this topic relates to the upcoming "Great Conjunction" between Jupiter and Saturn, which will be visible over most of the latter half of December. Closest approach will be on December 21, at which time the two will approach within 0.1 degrees of one another. While conjunctions of Jupiter and Saturn occur every 20 years, this is the closest one in at least several hundred years, and will be the closest one for as long as any of us reading this will be alive. So hopefully (since it'll be over by the time you read this!) you got a chance to see the Great Conjunction.

Following Andrew's presentation, Programs Chair Jeremy Carlo introduced the evening's speaker, Dr. Emmanuel Schaan of Lawrence Berkeley National Laboratory. A postdoctoral researcher, Dr. Schaan's presentation was entitled "A Cosmic Shadow Theater: How Galaxy Silhouettes Reveal the Invisible Universe."

Emmanuel started by showing a satellite photo of Earth taken at night. Of course, you can see many bright lights delineating cities and towns. It stands to reason that brightly-lit areas are likely to be more populated than the less-lit areas. But this isn't always true, as there are areas on the globe with relatively few lights but large populations, such as North Korea and much of Africa. Rather than delve into a geopolitical discussion, we can surmise that while light can be used to infer the population distribution, it is a *biased estimator*. It's going to lead us astray. There are heavily-populated places without many lights, and presumably there may be sparsely populated places with plenty of

lights (e.g. a military installation or large industrial site).

Emmanuel then showed a photo of many galaxies. What are we seeing? The light. And the light is likely to be a biased estimator of where the mass is located. In particular, we know from several lines of evidence that galaxies are surrounded with large haloes of nonluminous matter, which have mass but do not emit light. Unfortunately, our (ordinary) telescopes cannot (directly) detect this nonluminous matter.

As it turns out, what we see in those photos is only a tiny fraction of the total mass in the universe. We know from cosmological studies that about 70% of the universe's energy density is in the form of "dark energy," a very strange entity which causes the universe's expansion to accelerate. A further 25% or so is in the form of "dark matter," which not only is dark, is also not made up of atoms or any of the familiar subatomic particles we know and love. It's something else entirely. That leaves about 5% of the universe - 1/20th of the total - in the form of "baryonic matter," which is a fancy term for "atoms and molecules." But wait, there's more! Even considering only that measly 5% in the form of baryonic matter, it turns out that only 5-10% of that is contained in stars (which of course are the things we see in those photos). The other 90-95% of the baryonic matter doesn't emit (much) light. Where is it? Well, some of it is in the form of planets and the like, but most of it is in the form of very rarefied gas and dust filling the space between stars and galaxies.

The question then becomes, How do we trace out this "missing baryonic matter?" And the answer is to backlight it, much like a shadow theater. Emmanuel showed some photos of dark clouds in front of a brightly lit sunset scape.

Of course, getting a backlight behind distant galaxies is quite a challenge. Imagine how big it would have to be, and how long it would take to put it there! Fortunately, Nature has already provided a perfectly usable backlight, in the form of the Cosmic Microwave Background (CMB), a relic of the Big Bang some 13.8

The December Monthly Meeting (continued)

(Continued from previous page)

billion years ago. The CMB quite uniformly illuminates the sky in all directions; if you compare the intensity of light coming from any part of the sky with any other, the variations are smaller than 1 part in 10,000! This is exactly the sort of uniform backlight which we need.

Now, how do we “see” the silhouettes of these galaxies being backlit by the CMB? The answer lies in something called the Sunyaev-Zel’dovich effect (SZE). Essentially, CMB photons passing through these galaxy haloes interact with the gas as they go through. They can either lose some energy in scattering processes and become redshifted, or gain some energy and become blueshifted; what we see is a slight shift in the wavelength dependence of the radiation coming through. So it’s not exactly a “shadow” in the sense we’re used to, but it has a definite indelible effect.

There are two types of SZE. There is a kinematic SZE, which tells us about bulk gas motions and density. There is also a thermal SZE, which tells us about the temperature of the gas. (Hotter gases have faster-moving molecules, so the CMB photons scatter off molecules moving with a wider range of velocities.)

With the physics out of the way, Emmanuel talked about some of the instruments used to probe this “cosmic shadow theater.” The Atacama Cosmology Telescope (ACT) is a 6-meter telescope in Chile which images microwaves with an angular

resolution of about 1 arc-minute (similar to the resolution of the naked eye). To detect these low-energy microwaves, extremely low-temperature superconducting detectors must be used, which is a fascinating subject in its own right.

Now, here’s the problem. This Sunyaev-Zel’dovich effect is *tiny*. Ridiculously tiny. Emmanuel showed some pictures of individual galaxies. Yeah, maybe there’s something there, but it’s so noisy you can’t really tell. So you use a technique familiar to astrophotographers: stacking. If your noise levels are high, stack many images together to “beat down” the noise. (More topically, this is why opinion polls survey a large number of people, and why vaccine trials have to enroll large numbers of participants: you need to beat down the random noise which would dominate your signal if the sample size is too small!) This technique works very well, but the convergence is slow. Roughly speaking, to beat the noise level down by a factor of two, you have to increase the sample size by a factor of 4. (More generally, to drop the noise by $1/N$, you have to increase the sample size as N^2 .) It works, but it’s slow.

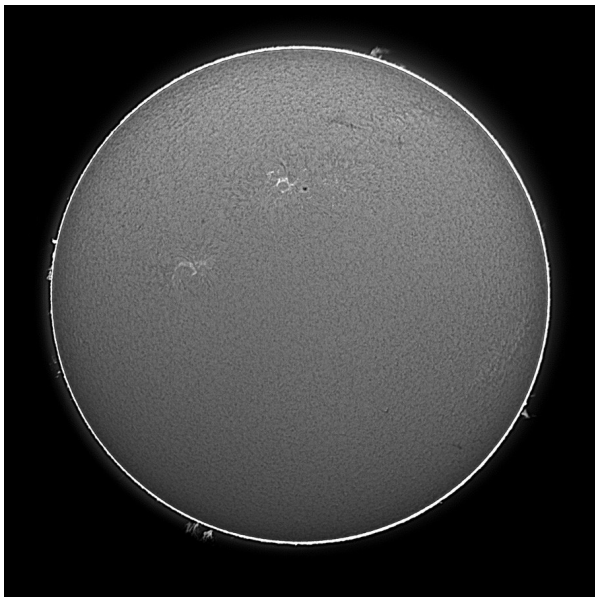
In this case, the signal-to-noise ratio is about 1:100, so to get a usable signal you must stack images of $100^2 = 10,000$ galaxies. Fortunately, there are survey catalogs with hundreds of thousands of galaxies to choose from. With that, Emmanuel showed us a picture produced using several thousand galaxies, in which the spherical mass

halo can be clearly seen! Unfortunately, since this is produced by averaging over thousands of galaxies, it precludes us from knowing anything about the individual galaxies, only about their ensemble average (just as a poll can’t tell us how any individual voter will vote).

Emmanuel finished with a discussion about much more capable instruments coming online in the future. DESI is a spectrograph which can take spectra of 5000 galaxies at once, enabling extremely quick characterization of thousands of galaxies. The Simons Observatory is a new telescope being constructed in Chile which will significantly expand upon the capabilities of the ACT.

Emmanuel concluded by pointing out that this is still an emerging field, and what we’re seeing now is only the very beginning. With a new generation of instruments on the horizon, we’ll be able to map out the mass distribution of the universe to higher and higher levels of precision. We’ll be able to produce separate images for different types of galaxies, different sizes and orientations of galaxies, and so on, in much the same way that a very large poll can be broken down to show voting preferences of voters by individual states, races, age groups, and so on. Stay tuned for further developments!

Many thanks to Dr. Emmanuel Schaan for a very enlightening presentation on this burgeoning field of research!

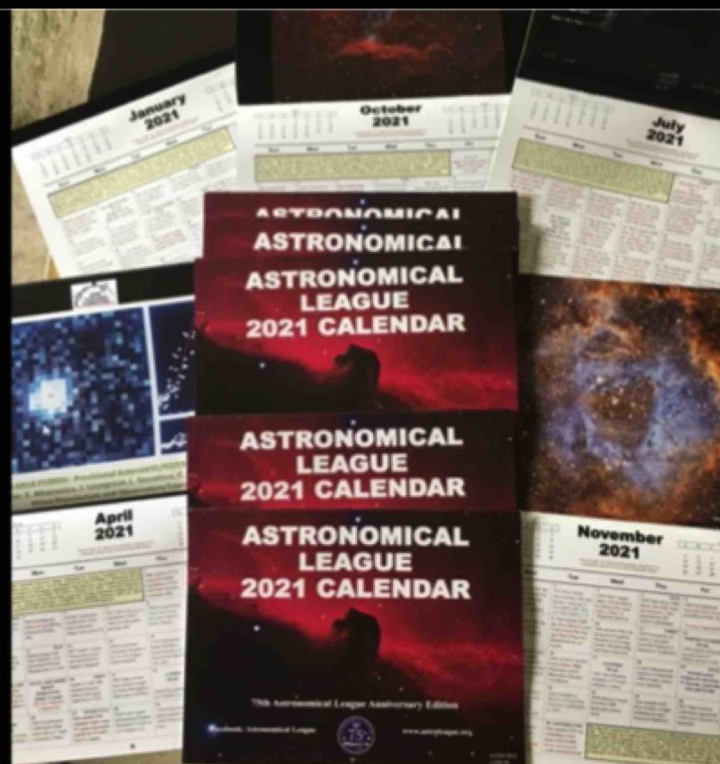


(above) the Sun, imaged in H-alpha by Wayne Reed on 12/7/2020 with a Lunt LS60THa scope and Canon T7i camera, ISO 1600, 1/160 second for surface, 1/10 sec for prominences. 50 frames stacked for surface, 65 frames for limb. Processed through Photoshop Elements, Autostakkert, Registax, and composited in Photoshop Elements.



(above) The Jupiter-Saturn conjunction, imaged by Barry Johnson through his Celestron 8, 2000mm, f/10, 1/4 sec. at ISO 800.

Astronomical League 2021 Calendar



2021 AL Calendar - 75th Anniversary Collectors Edition

Celebrating our 75th year November 15, 1946

The 75th Anniversary Planning Committee encourages your purchase as these calendars have historical notations of the Astronomical League.

Starting in January, events are planned that tie in to the month's trivia.

The profits from the sales goes to the ALCon Jr. budget.

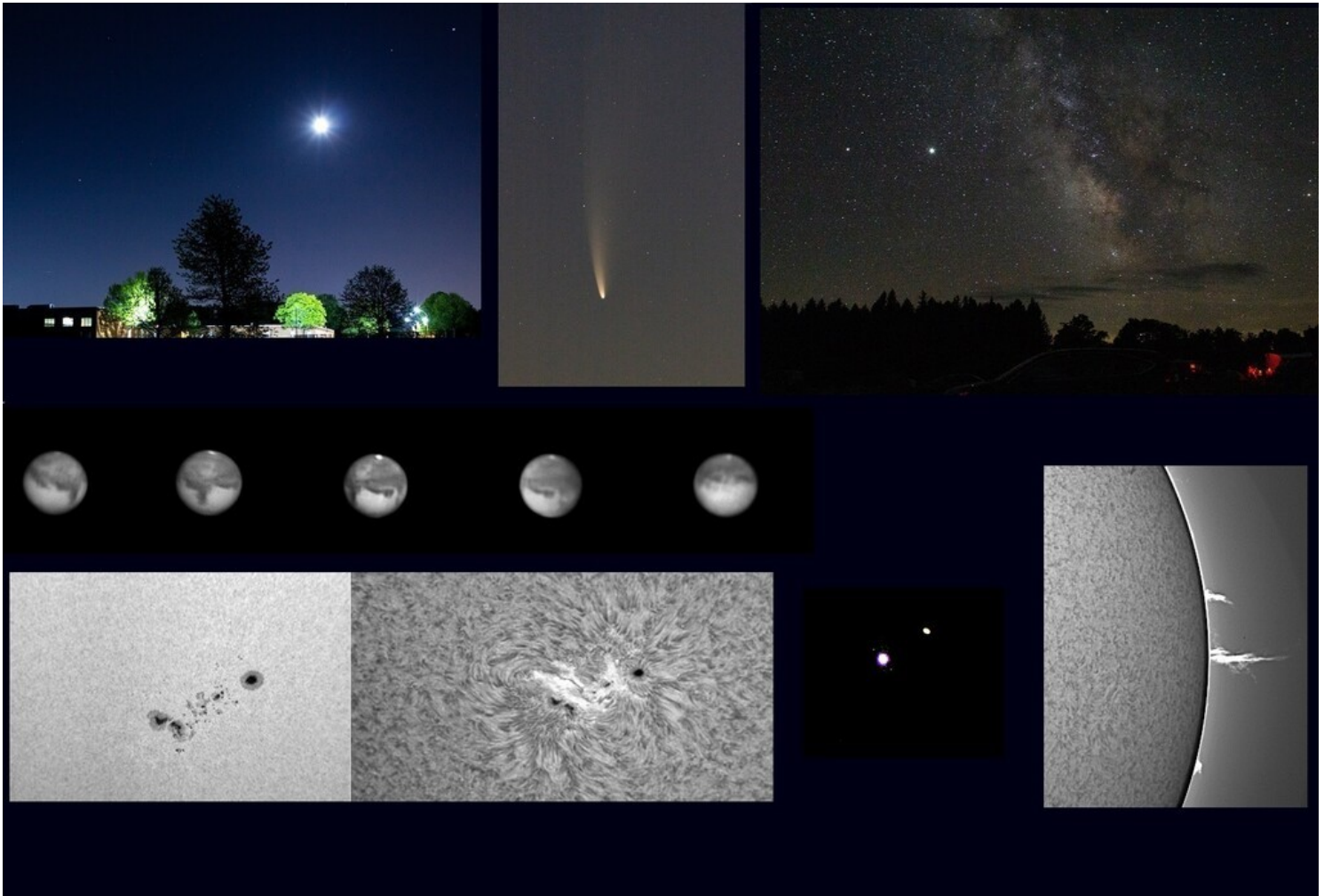
**THANK YOU FOR YOUR CONTINUED SUPPORT AND
ENJOY OUR ANNIVERSARY CELEBRATION YEAR!**

To clubs holding a December/Holiday on-line meeting:

Add some pizzazz to your event by holding a "door" prize drawing with the winner receiving an AL 2021 Calendar. If an order is placed directly through League Sales, it will be safely shipped to the winner. No need to worry about how to have it shipped or delivered!

League Sales: store.astroleague.org

Astrophotos



(above) Images by Tom Nolasco. While 2020 has had its many challenges it also was a very good year for astronomical diversions. Tom has attached a composite image of some of 2020's astronomical high points. Clockwise starting from upper left we had:

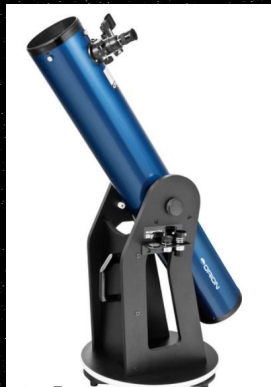
- March through May brought a beautiful morning alignment of Jupiter, Saturn, the Moon & Mars.
- July brought Comet Neowise, the brightest comet in over 20 years.
- By summer a socially distanced Cherry Springs State Park opened for camping.
- In May the first signs of the Sun awakening were occurring.
- December brought us the great conjunction of Jupiter and Saturn.
- In early and late November the Sun's activity level increased dramatically.
- And of course, the autumn gave us closeup dust storm free views of Mars.

DVAA Telescope Rentals

Celestron NexStar 5SE



6" Orion Dobsonian



DayStar 60 mm Solar Telescope



6" Orion StarBlast Dob



All scopes include tripod/base, eyepieces, manuals, power, etc. Rental is \$10/month with \$20 deposit. More info at www.dvaa.org under the OBSERVING tab. To rent one of these scopes, contact Joe Lamb at rentals@dvaa.org.

The Delaware Valley Amateur Astronomers

Since 1976, the **DVAA**, a non-profit corporation, has **shared the wonder and science of astronomy** with thousands of amateur astronomers and the public in the Philadelphia area. Each month we host dark-sky and local star parties, telescope workshops, science & astronomy lectures, educational outreach sessions, and more. To learn more or to join DVAA, please visit www.dvaa.org.

Check the schedule for our **free monthly meetings open to the public**, usually held on Friday evenings at the Radnor Township Building Radnorshire Room (1st Floor)
301 Iven Ave.
Radnor, PA 19087

get in on the fun:
JOIN the DVAA TODAY!

Dues are \$40 per year for an individual, \$60 for a Family Membership, or \$10 for a Junior or Student Membership. **Membership benefits** include our monthly newsletter, membership in the Astronomical League (including its publications), access to our dark-sky observing sites, and inexpensive rentals of fine telescopes. You can join or renew online at www.dvaa.org. DVAA members can purchase discounted subscriptions to *Astronomy* magazine through the DVAA treasurer and *Sky & Telescope* (through Sky Publishing). Amounts can be combined on one check. If paying by mail, include a note stating what you are paying and membership category desired. Make checks payable to "DVAA" and send to our treasurer: Louis Berman, 477 Turner Avenue, Drexel Hill, PA 19026, or for more information contact treasurer@dvaa.org.

