SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

October 2019

The Deer Lick Group and Stephan's Quintet by Gary Miller

The Deer Lick Group of galaxies is at the lower left. Its largest member is NGC7331, magnitude 10.4. Stephan's Quintet is at the upper right, 0.5 degree away. The image is a stack of 26 three-minute guided exposures, with darks and bias frames subtracted, processed in PixInsight. 127mm refractor on AVX mount, DSLR camera. There are a number of fainter NGC and PGC galaxies (Catalogue of Principal Galaxies) in the image. See the map on page 19.

WAA October Meeting

Friday, October 4th at 7:30 pm

Lienhard Hall, 3rd floor
Pace University, Pleasantville, NY

CCD and CMOS Sensors for Astronomy: An Introduction and Comparison

Jules Insler
Senior Principal for Systems Engineering, BAE Systems

The world of imaging is undergoing constant change and improvement. CMOS sensors are replacing CCDs, the miracle that replaced film. Jules Insler is an expert in imaging devices. He is best known as the inventor of the laser printer.

Pre-lecture socializing with fellow WAA members and guests begins at 7:00 pm!

New Members

Liv Andersen	Brooklyn
Brian Chipman	North Salem
Kim Hord	Dobbs Ferry
Arno and Lenore Housman	Croton-on-Hudson
Patricia Frasier & Myrna Morales	New York

Renewing Members

Thomas Boustead	White Plains
Michael & Ann Cefola	Scarsdale
Peter Germann	Katonah
George & Susan Lewis	Mamaroneck
Emmanouil Makrakis	Scarsdale
Satya Nitta	Cross River
David Parmet	Mt. Kisco
Steve Petersen	Katonah
Christopher Plourde	New Rochelle
William Rothman	Bronxville
Harry Vanderslice	Mamaroneck
Lori Wood	Yonkers

Also In This Issue

WAA November Meeting

Friday, November 1st at 7:30 pm

Lienhard Hall, 3rd floor
Pace University, Pleasantville, NY

Christopher Clavius & the Gregorian Calendar

Paul R. Mueller, S.J., Ph.D.
Superior of the Jesuit Community and Vice Director, Vatican Observatory, Castel Gandolfo, Italy, and Tucson, Arizona

In this year marking the 480th anniversary of the birth of Christopher Clavius, S.J., it seems appropriate to focus on his life and legacy. That legacy ranges from the Gregorian calendar, which is the calendar that we all use today, to the Stanley Kubrick film *2001: A Space Odyssey*. It ranges from popular textbooks to worldwide curricular reform. And it ranges from the history of science in China to the Vatican Observatory, which Pope Gregory XIII established in 1580 to help confirm and refine astronomical observations made in support of Clavius' reform of the calendar. Paul Mueller, S.J. will explore Clavius' life and work in their early and modern contexts and illuminate his enduring legacy for modern science, religion, and culture.

WAA Hotline: 1-877-456-5778 (toll free) for announcements, weather cancellations, or questions. Also, don't forget to visit the WAA website.

Starway to Heaven Star Party

Meadow Picnic Area Parking Lot
Ward Pound Ridge Reservation,
Cross River, NY

October 19th (rain/cloud date October 26th)

Bring your own telescope or view through members' instruments. Free and open to the public. Check the WAA phone hot line for last-minute weather updates.

Westchester Amateur Astronomers

ALMANAC For October 2019

Bob Kelly, WAA VP for Field Events

1Q 10/5 | Full 10/13 | 3Q 10/21 | New 10/27

Saturn goes through quadrature early in the month, which is less painful than it sounds. At 90 degrees (a ‘quarter’ of the way) across the sky from our Sun, we get our best peek ‘around the corner’, including seeing the planet’s shadow on its rings.

Get out early to see Jupiter before it sets at about 9pm, followed by Saturn-set 1¾ hours later. Nevertheless, since the Sun sets just after 6pm EDT, we still have several hours to view the giant planets. Iapetus starts the month as Saturn’s third brightest moon, at magnitude +10.2, looking out of line with the others, well to the west of Saturn. By the 22nd, Iapetus passes just to the north of Saturn, a bit dimmer as we see more of its dark side. Saturn appears with its maximum ring tilt for the year, its sombrero tipped 25 degrees toward us, which gives us a fine view of the rings.

What more can I say about Jupiter? Just come on out and look at its moons, and sometimes their shadows on the striped planet, while we still have the King of the Planets for the next month or so!

Start making plans to view Mercury’s five-and-a-half-hour-long transit across the Sun’s face on Monday, November 11th, a federal holiday in the USA. You’ll need a telescope that can give good views at magnifications of 50 to 100 times or more, since Mercury will be only 1/10 the apparent size of Venus during its 2012 transit of the Sun.

WARNING! The telescope you use must have a good-quality, solidly attached, solar filter (or use a hydrogen-alpha telescope).

In the meantime, watch Mercury get a little high in the evening sky. The best view of its excursion from the solar glare is from the southern hemisphere. Mercury will be farthest from the Sun on the 19th. As Mercury’s right-hand woman this month, Venus will help us find the fainter inner planet, even though neither gets more than ten degrees above the horizon, even at sunset. In a telescope, Venus and Mercury both appear at least half-full this month. A thin 44-hour-old moon floats above them on the 29th.

The Orionid meteor shower peaks during American daytime on the 21st, so best viewing will be pre-dawn on the 20th or 21st. The 20-or-so meteors an hour will be competing with light scattered from the last quarter Moon.

Far-out Uranus is magnitude +5.7 and opposite the Sun from us on the 28th. Only 3.7 arc seconds wide, compared to Jupiter at 35 arc seconds, it’s a tiny thing to see. But, with a good finder chart[1], Uranus is worth some study with a telescope, which will show it as a distinct disk. Its even-farther-out buddy, Neptune, just past last month’s opposition, is well up in the evening sky at magnitude +7.8 and 2.3 arc seconds wide. Compare these two disks in a telescope with the point-like stars around them. Add your observations to the discussions about the color of these ice giants are and how they differ.

Bob’s photo of the waning gibbous moon in the early morning of September 21. Canon XS on tripod, lens EF-S 55-250mm f/4-5.6 IS at 250 mm, 1/125 second at f/7.1, ISO 100. RAW file cropped and processed by the Editor in Canon Digital Image Professional 4.

In case you missed it, our Moon shows the best view of the Apollo 11 landing site on the evening of the 4th. My favorite phase, the waning gibbous phase just

[1] Sky and Telescope’s Uranus and Neptune finder charts are at https://s22380.pcdn.co/wp-content/uploads/WEB_UrNep_2019-2020_updated.pdf, or you can use any good planetarium program.

before last quarter, is highest in the sky this month on the 19th and 20th. It'll be a good time to spy the Moon in the morning, even after sunrise. At that time of the month, we'll be able to peek at an extra six degrees of longitude around the western limb of the Moon.

If you want to reconnoiter the upcoming winter sky, the post-midnight sky is the place to watch. It's easier than usual since sunrise is very late in October. Thanks to Daylight Time, the Sun will rise after 7am for most of the month, with total darkness lasting until 5:30am EDT.

Mars is the only bright planet up before dawn, showing up low in the east later this month. At +1.8 magnitude, Mars is only about as bright as the brightest stars in the Big Dipper. Mars is too tiny to see details in a telescope now, but next October it'll appear six times wider and four magnitudes brighter.

Mars's northern hemisphere celebrates its Summer Solstice on the 7th. The effects of solstices are more complicated on Mars than on Earth because Mars's orbit is much more elliptical than Earth's. This solstice, only two months after Martian apogee, makes for a very cold winter in the southern hemisphere and perhaps a weaker summer for the north. Something to consider when you book your vacation trip to the Red Planet.

The International Space Station is visible to the unaided eye sailing across the evening sky through the 11th and the morning sky starting on the 23rd.

WAA Members: Contribute to the Newsletter!
Send articles, photos, or observations to
waa-newsletter@westchesterastronomers.org

Editor: Larry Faltz
Assistant Editor: Scott Levine
Editor Emeritus: Tom Boustead

Uranus and 4 of its Moons by Scott Nammacher

On the night of September 21st Scott used a 12½-inch PlaneWave telescope and SBIG 10XME camera to make this image of Uranus surrounded by four of its moons. He used very short exposures, just 2 seconds for the luminance frames and 8 seconds for each RGB filter. Processed in MaximDL and Photoshop.

Four satellites of Uranus are visible. Counter-clockwise from the 11 o'clock position are Titania (mag 13.9), Oberon (14.1), Umbriel (15.0) and Ariel (14.3). The other satellites (there are 23 more) are too faint to be seen. On the left is star UCAC4-515-003519, mag 10.43, color index 1.60 which would make it red, as it indeed appears.

Member Profile: Josh Knight

Home town: Mohegan Lake, NY

Family: Wife Mary Ann

How did you get interested in astronomy? My mother and father were both science teachers. As long as I can remember, my father would point out the planets, constellations and the Milky Way in the night sky, especially when we lived on a farm in northeastern Missouri with quite dark skies.

Do you recall the first time you looked through a telescope? What did you see? I am not sure whether it was near Canton, MO with a telescope owned by a faculty member of Culver Stockton College or my uncle's telescope (both small refractors) near St. Louis, but I'm sure what was on view was planets, probably Jupiter, but perhaps Saturn.

What's your favorite object(s) to view? For me globular clusters and open clusters. When I show the sky to non-astronomically experienced folks, I like to observe the Moon and planets.

What kind of equipment do you have? A 1975 orange tube Celestron 8-inch Schmidt-Cassegrain.

What kind of equipment would you like to get that you don't have? I'm waiting for an eVscope from Unistellar (https://unistellaroptics.com/).

Have you taken any trips or vacations dedicated to astronomy? Tell us about them. We visited New Mexico Southern Skies in 2011, and I reported on that visit in a WAA Member's Night talk in 2012.

Are there areas of current astronomical research that particularly interest you? I have a PhD is in Solar Physics, so I'm interested in that, but also I'm interested in most things in astronomy and astrophysics.

What do you do (or did you do, if retired) in "real life"? I finished my PhD in solar physics in 1978, and I continued research and teaching at Stanford until 1981 when I joined IBM. I worked there for more than 34 years until I retired at the end of 2015. I have been more active in WAA and other astronomy events since I retired.

Have you read any books about astronomy that you'd like to recommend? Despite all the advances since it was first written, Steven Weinberg's *The First Three Minutes* is still very good.

How did you get involved in WAA? I met Robert Baker at Stellafane and he recommended I look into WAA.

What WAA activities do you participate in? Some meetings, more star parties and outreach events since I retired.

Provide any other information you think would be interesting to your fellow club members, and don't be bashful! In 1980 I decided that I should figure out what I was going to do: stay with astrophysics or do something else (in my case computer science). I applied for every open astronomy/astrophysics job I was even remotely qualified for and received an amazing number of rejection letters. One interesting example was from the University of Oklahoma which was a pre-printed postcard! At the end of this process, I received an offer for a tenure track position as an assistant professor of physics and astronomy at Cal State Northridge. This job required a full time teaching load, but the decision about whether or not I would get tenure would be based on the research that I was able to squeeze in around that work. That didn't sound that great, but the school had a very nice solar telescope that was jointly operated with Lockheed Martin. But I decided to pursue computer science as a profession instead. I changed from being a professional astrophysicist and amateur computer scientist to being a professional computer scientist and amateur astronomer.

In the Naked Eye Sky: From the Horse to the Horns
Scott Levine

Years ago, on a quiet and anonymous night, I made my way outside with a cup of badly microwaved tea and looked for some old friends. With a few flicks of a pen a few days before, my wife and I become the proud owners of not just one, but three toilets and a pile of debt that felt like it could knock Cassini out of orbit.

As I sat there that October night, the early fall air still clinging to the last threads of summer, I heard the hiss and clack of the front door closing, giggling voices, and then a miniature, warm hand on my shoulder. Through the maple and oak leaves, we watched the Great Square of Pegasus twist into view, with Andromeda following behind. Her stars dotted just above the branches, underlining and emphasizing the upper half the sky.

At the start of the month, the Square sits sideways during the middle evening, like a giant baseball diamond. The “third-base” star is Alpheratz (α And), a second-magnitude star just under a hundred light years away. Alpheratz is one of a bunch of stars that are interesting not for any particular scientific reason (though, they all are), but because they’re at an intersection of the science and the human side of astronomy. At one time or another they’ve all been part of more than one constellation. Astronomers from the time of Ptolemy saw Alpheratz as both part of Pegasus and Andromeda. It formed both the princess’s head (or feet, depending on the drawing) and part of the flying horse’s midsection. It wasn’t until the official constellation boundaries were set in the early 20th century that it became part of just Andromeda.

But October is an interesting time. Just like the weather, this month’s constellations are changing and almost seem nervous and unpredictable. October’s stars seem to speed by and push past us much faster than at other times.

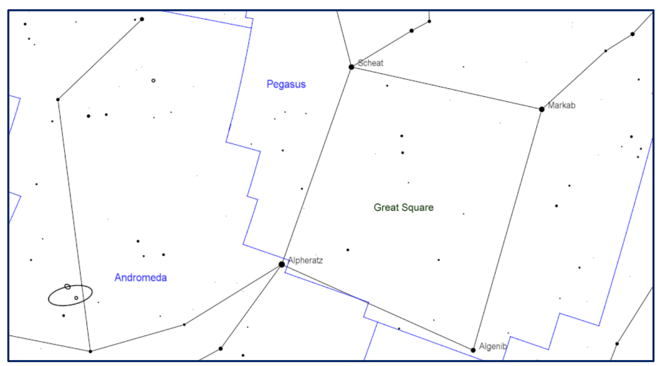
Before long, a strong gust of wind will blow through, the last leaves will fall, and a pile of grown men will celebrate in the middle of a field and plunge us into the dark end of the year. We’ll be left with cold air and bare branches. Behind them, though, are the bright lights of winter.

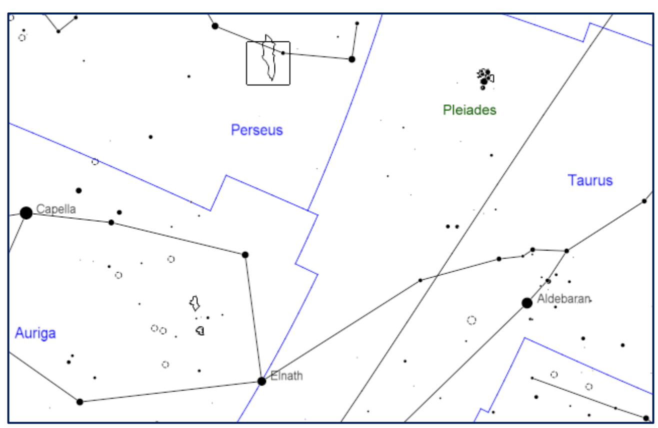
By the end of the month, Taurus joins the October night. Its second brightest, Elnath (β Tau), also second-magnitude, forms one of the bull’s horns. It’s about 130 light years away. Ptolemy and friends shared it, too, across two constellations. Like Alpheratz, when astronomers drew the constellation lines and signed the treaties, it became part of only Taurus; cut off from neighboring Auriga.

After that first night, that stretch of sidewalk became my favorite north-facing spot. With a quick twist to the left, it magically becomes my favorite south- or west-facing spot. Over the years, it became our place to take a break and watch crows, scorpions and teapots parade across the sky as bats dart overhead or watch the winter Sun drop from the sky like an egg from a table.

We leaned back and, with grass poking our ears, held onto what could have been another anonymous moment. We looked up at the anonymous stars in the middle of Summer Triangle and listened to the last few crickets and katydids chirp.

And we waited for the wind to blow.





Scott Levine’s astronomy blog, *Scott’s Skywatch*, can be found at https://scottastronomy.wordpress.com/

Spectroscopy of Nova V3890

Rick Bria

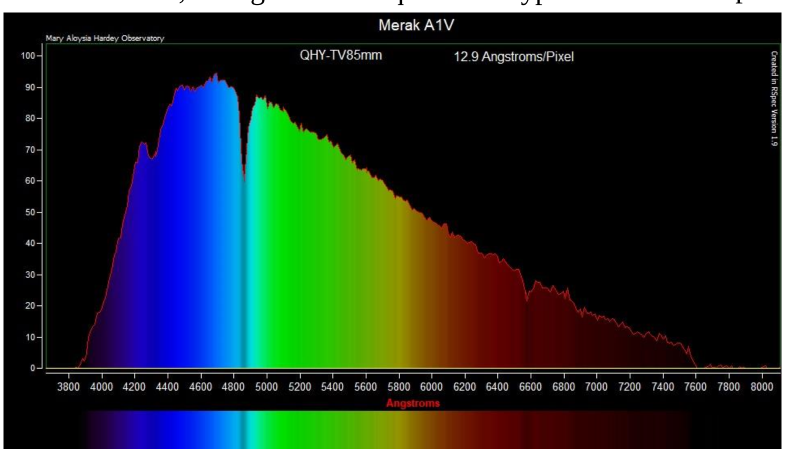
On August 27, 2019, binary star system V3890 in Sagittarius flared into a nova. Half the stars in the sky have companion stars orbiting close to them. V3890 consists of a small white dwarf star with an ordinary 'Sun-like' companion orbiting very close to it. The white dwarf is constantly pulling hydrogen gas off the larger companion star. About every 28 years, this material reaches a critical mass on the surface of the white dwarf and explodes with almost unimaginable force. Astronomers call this a nova. For several days the dwarf is hundreds of times brighter than it was before. After a few weeks it fades, and the process repeats. V3890 previously erupted into a nova in 1962 and 1990.

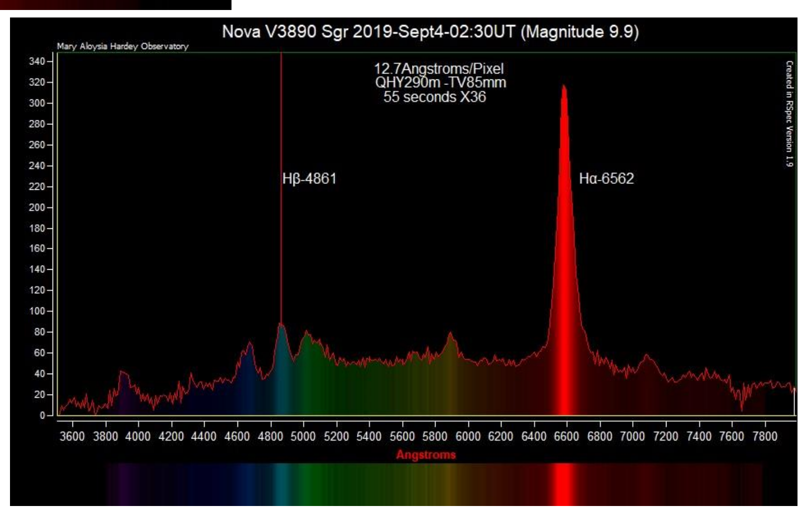
On September 4th, the Mary Aloysia Hardey Observatory recorded the spectrum of Nova V3890, which had faded from a maximum of 6.7 on August 27th to around 9.0 (it will eventually fade to around magnitude 18.0). We compared the spectrum with the spectrum of Merak, a bright main sequence A-type star in the bowl of the Big Dipper. As presented in the two attached spectra, the difference is dramatic.

Merak emits light in all visible wavelengths from blue to red, and shows a typical stellar spectrum with specific wavelengths absorbed by atoms in the star's atmosphere, seen as dips in the spectrum. Nova V3890 emits light almost exclusively in red, in the wavelength known as hydrogen alpha, and shows a bright line at that wavelength (656.28 nanometers).

Nova V3890 is about 2000 light years away. Astronomers can't see the individual stars of the pair and so they measure the total light coming from the system. It amazes me how astronomers can figure out what occurs in systems such as V3890 simply by measuring the light during the nova phase.

The spectra were obtained with a Star Analyzer 100 filter using a Televue 85 refractor and QHY290M camera (36 images, 55 sec each), processed with Rspec software.





A Different Perspective on the Sky

Robin Stuart

Note: For best viewing of the stereo images, adjust the size of the newsletter page on your computer so that the stereo images are about 60 millimeters apart (center-to-center). If you are printing the newsletter, the images will be at the proper distance on the page. View them from approximately 16 inches away (screen or print).

Figure 1: Stereoscopic pair made by combining photographs of the Moon for different librations. Taken at Yerkes Observatory created by the Keystone View Company.

The Hudson River Museum in Yonkers, New York, is hosting (through January 12, 2020) a fascinating and engrossing display of lunar photography to commemorate the 50th anniversary of the Apollo 11 Moon landing. Also on exhibit as part of the permanent collection in the adjoining Glenview Historic Home are several very early examples of stereoscopic views of Moon like the one shown in Figure 1. Copies and an old fashioned stereo viewer are provided for the visitor to experience the effect first hand.

The stereoscopic views were constructed by pairing and aligning photographs taken at different times, when the Moon's libration gave slightly different perspectives. A history of the early efforts in this area is given in an article entitled "The First Stereoscopic Pictures of the Moon" by T. B. Greenslade in the *American Journal of Physics* (1972) **40**, 536-540. More recent efforts using this approach can be found at https://apod.nasa.gov/apod/ap070602.html.

Musing on these examples I came to the realization that I had all the tools at my disposal to create stereographic pairs from a *single* image, meaning that I wouldn't have to wait months between favourable librations. I resolved to give it a try.

When we look at an image of the Moon in print or on a screen, we know intellectually that it represents the surface of a nearly spherical body and can infer the relative positions of each point of the image in space but we don't perceive the three dimensional character of the image directly.

Seeing in Stereo

In order to see in 3D, images from differing viewpoints need to be presented to each eye. The brain is then able to synthesize them in such a way that the combined image miraculously "pops" and we *perceive* the third dimension directly.

There are a variety of methods to achieve the desired stereoscopic views. One is to use a special viewer that takes two separate images and feeds one image to each eye. An Internet search shows that these are available in a wide range of old and new styles and configurations. The Viewmaster, popular in the 1950's and 60's, is fondly remembered by those of a certain age.

It is, however, possible to train your eyes to combine side-by-side stereo pairs without recourse to special viewers. There are two ways to do this and they are referred to as "parallel" and "cross-eyed" viewing. In parallel viewing the images are placed side by side, left image on the left side and right on right just as in Figure 1 (p. 8). The trick is to train each eye to look straight ahead at just one image. To do this it may be helpful to start by placing the images very close to your face and then move the page slowly back keeping your eyes fixed on the separate images. Alternatively a piece of cardboard placed at right angles to the page may help to ensure that each eye sees only the appropriate image. Parallel viewing is what the eyes are doing when looking at those random stereograms that were popular a number of years ago. Cross-eyed viewing is just what it says it is. The left and right images are reversed and you look at them cross-eyed until you see them "float." Then you move them around with your eyes until they coalesce and fuse into a single 3D view. Looking at the images in this way can be helpful in that it tends break the connection between focus and convergence of the eyes and I personally find it the easier technique to use. For parallel viewing the images must be separated by no more than roughly the interpupillary distance for an average adult, around 63 mm. The requirements for cross-eyed viewing are less severe.

In the case of 3D movies, images are projected through crossed polarized filters and are viewed while wearing polarized glasses. In this and the other approaches described so far the images are seen in full color but require some practice or specialized equipment. If one is willing to sacrifice some color fidelity the 3D effect can be achieved with a much more modest outlay in which the image separation is achieved by a pair of colored filters mounted in a cardboard frame. These are known as anaglyphs and the simplest type uses red and blue filters. Left and right images are converted to black and white and then assigned respectively to the red and blue channels of a color image. This indeed produces the 3D effect but the colors look unnatural. A better way is to use so-called red-cyan filters. To create a 3D color image the red channel of the right image is replaced by the red channel of the left image. Red-cyan filter glasses then direct the red channel of the image to the left eye and green and blue channels both to the right. The colors look natural and, when seen without the glasses, the image appears fairly normal but with some color fringing. Depending on the quality of the filters however the red filter may pass a certain amount of green light that can produce some ghosting in areas of high contrast.

Making a Stereo Pair from a Single Image

An image of the Moon taken from Earth represents a very close approximation to an orthographic or perpendicular projection of its surface[2]. Since the figure of the Moon is close to being spherical, points near the center of the image are obviously closer to the observer than points near the limb. Using some simple geometry the relative spatial positions of all the points in the image can be precisely determined. From there it is possible to compute where each point on the surface would appear to be for an observer located at a different vantage point.

There are a number of software packages that can map an image onto a spherical surface in some form or other (see for example J.-P. Metsävainio, "A New Way of Looking at the Moon", *Sky & Telescope*, January 2005, p. 142–146). However I wanted to ensure that I had precise control of the mapping process and potentially go beyond what is offered as standard. The Mathematica software package includes some powerful image processing capabilities along with its extensive core mathematical functionality. These features make it an excellent choice to perform the required manipulations. Figure 2 (p. 10) shows how a perspective view of the Moon's surface can be generated from a flat image. The Moon is represented by the gray disk and the direction of the Earth is indicated by the arrow labelled "⊕". The observer's position is indicated by the eye at lower right. The original photographic image is mapped or projected onto the Earth-facing hemisphere of the disk shaded lighter gray in Figure 2. The brown inclined line in the figure represents the image plane on which the new perspective view will be drawn. A point, **C**, is chosen to be the center on the new image. The pixel value of a point, **G**, on the image plane is found by drawing a line from the observer to **G** and noting at what point, **P**, it intersects the surface which identifies the corresponding pixel in the original image. When two views are produced for different positions of the observer, the results can be used to form a stereoscopic pair.

[2] In practice an Earth-bound observer doesn't quite see a complete hemisphere of the Moon due to its finite angular size in the sky.

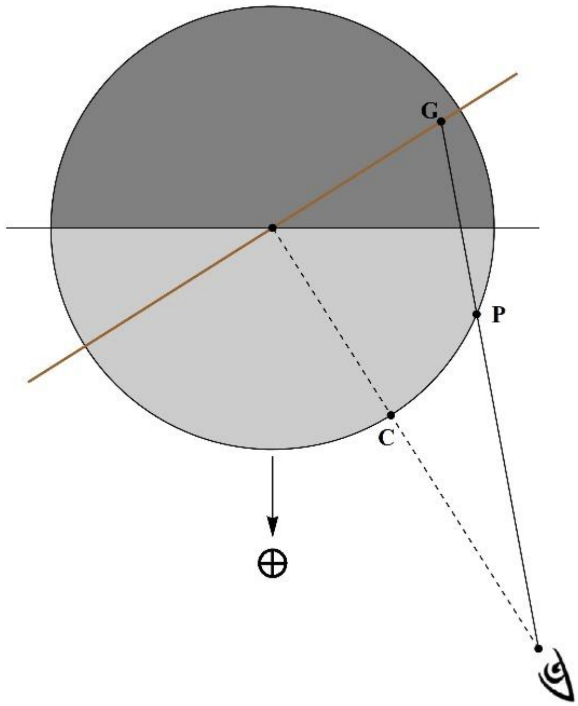


Figure 2: Perspective projection a point, **P**, on the Moon's surface to the point, **G**, on the new image plane (brown). Point **C** is the center of the Moon's disk as seen by the observer. The direction of the Earth is indicated by the arrow. The original photographic image of the Moon is mapped onto the lighter gray shaded hemisphere.

This procedure was applied to an image of the Moon I took on December 20, 2015. There is nothing special about it. It's just one showing a suitable phase that I found on my hard drive. The results are presented in various alternative forms for stereo viewing in Figure 3. These particular images have been constructed to be viewed at about 16 inches from the page. The star field is artificial and has been added for purely artistic effect. Figure 3a (p. 11) is a stereoscopic pair arranged for parallel viewing as described earlier. In Figure 3b (p. 11) the images are reversed and should be viewed cross-eyed. Figure 3c (p. 15) shows the images combined into a single red-cyan image which should be viewed through red-cyan filter glasses (red on the left eye).

The global figure of the Moon can now be perceived directly. What is not captured, of course, is the 3D structure of topographical features such as crater walls and mountain ranges.

The same basic methods and procedures described above can also be applied to other solar system bodies.

Saturn

Compared to the Moon which can be treated as a simple sphere, the view of the Saturnian system is a riot of geometric forms. The rings are circular and occupy a plane but as seen from Earth they present as an ellipse whose dimensions depend on the viewing angle. The figure of Saturn itself is an oblate spheroid which is also seen as an ellipse whose relative dimensions also depend on the viewing angle[3]. Because of their size and prominence, measurements of the ring in an image of Saturn can be made fairly easily and accurately. These then determine the observer's viewing angle and apparent figure presented by the planet. The information can be used to construct a three dimensional image of the Saturnian system. Figures 4a and 4b (p. 11) show the result applied to a Hubble Space Telescope image taken on June 6, 2018. A red-cyan stereoscopic image is also presented on page 12. The spatial positions of the moons are approximate.

Jupiter

Orbital parameters of the Jupiter and the Earth conspire in such a way that we only ever see Jupiter from very nearly within its equatorial plane and hence, unlike the case for Saturn, although it shows an elliptical profile, the apparent degree of flattening as seen from Earth is always approximately the same. Figures 5a and 5b (p. 12) show stereoscopic images generated from a 2017 Hubble space telescope photograph. A red-cyan stereoscopic image is presented on page 15.

Other Projections

The stereoscopic pairs were made by perspective projection but the machinery built to produce them can be extended to make other types of projection as well. All the projections discussed here are geometric in nature and can be implemented by means of standard operations on three dimensional vectors that are relatively fast and efficient and do not require the evaluation of trigonometric or other functions. Two other projections of interest are the orthographic and stereographic. Figures 6a and 6b (p. 13) show how they are created.

[3] Seen from above its pole Saturn's planetary disk appears circular and flattens as the observer approaches the equatorial plane.

Figure 3a: Stereo pair of the Moon arranged for parallel viewing

Figure 3b: Stereo pair of the Moon arranged for cross-eyed viewing

Figure 4a: Stereo pair of Saturn and its moons arranged for parallel viewing

Figure 4b: Stereo pair of Saturn and its moons arranged for cross-eyed viewing

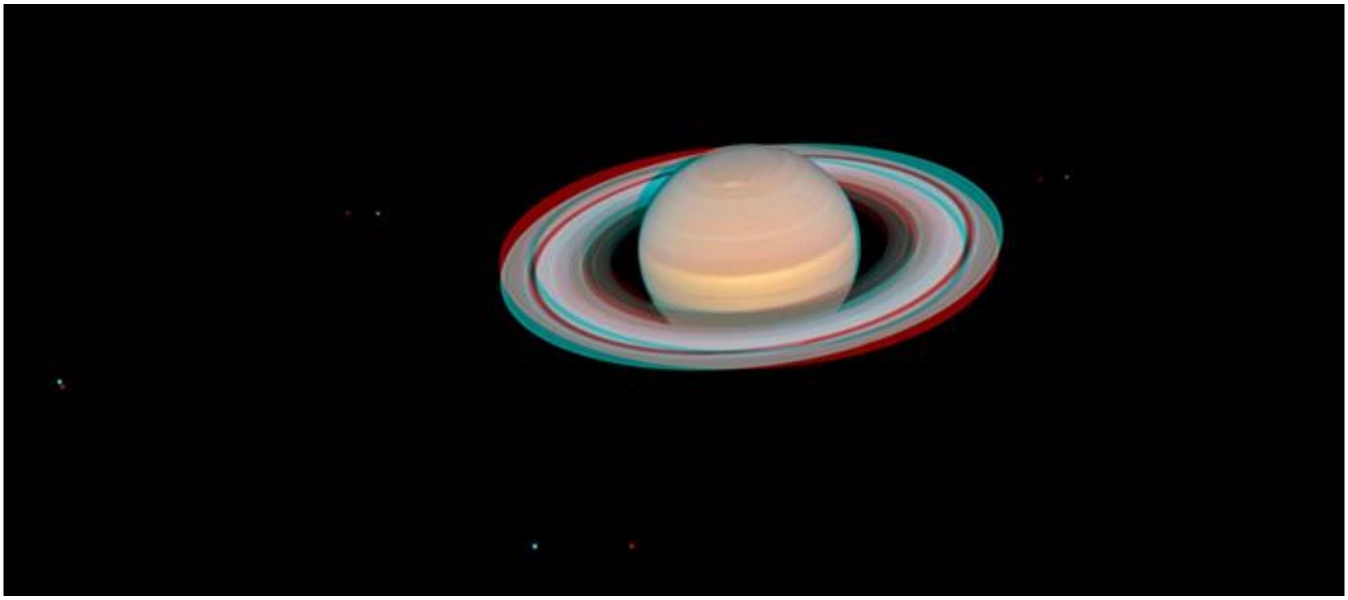


Figure 4c: Red-Cyan stereo image of Saturn and its moons

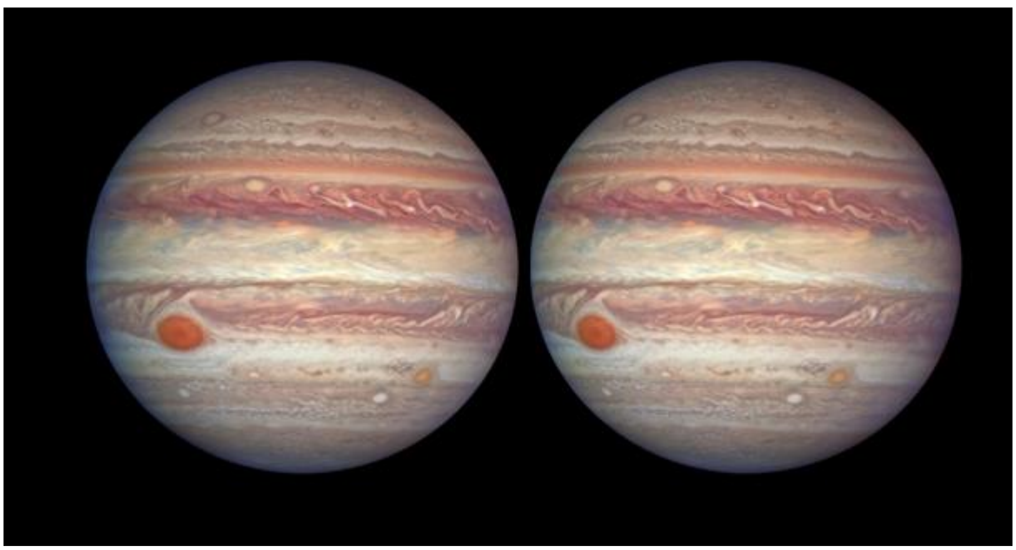


Figure 5a: Stereo pair of Jupiter arranged for parallel viewing

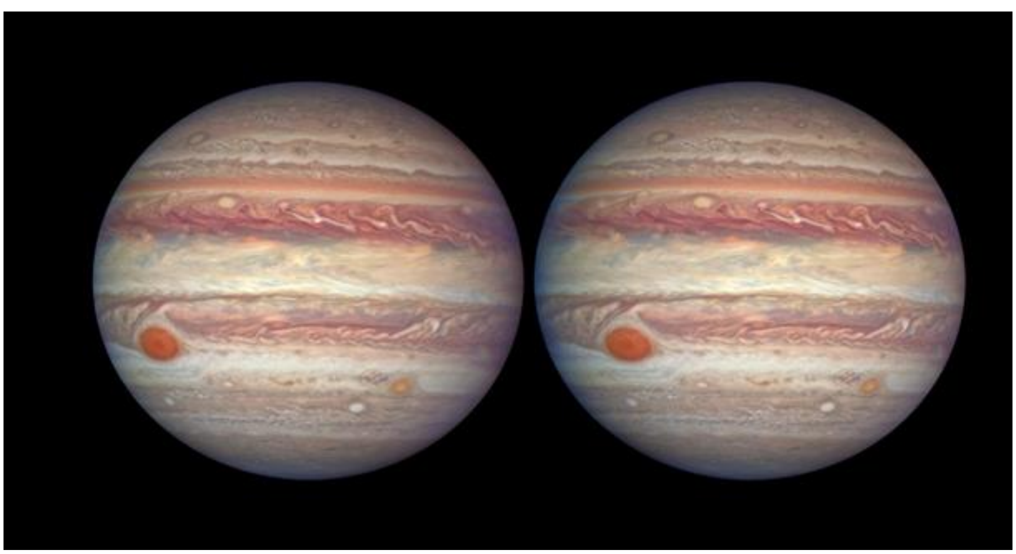


Figure 5b: Stereo pair of Jupiter arranged for cross-eyed viewing

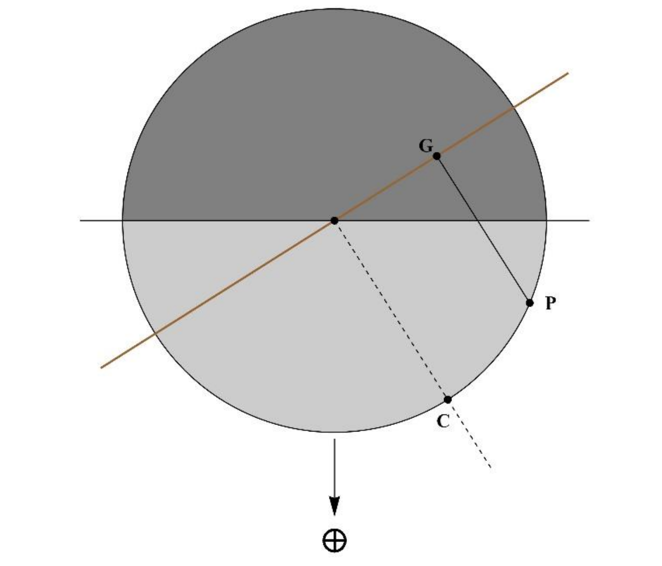


Figure 6a: Orthographic projection a point, **P**, on the Moon's surface to the point, **G**, on the image plane (brown). This is the limit of the perspective projection in Fig. 2 when the observer's distance is taken to infinity.

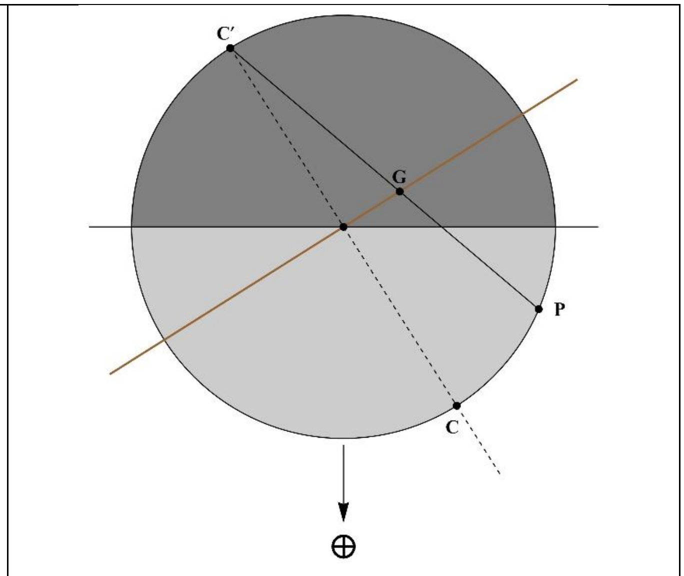


Figure 6b: Stereographic projection. The point, **C′**, diametrically opposite the Moon's center in the final image (**C**), is connected to a point, **P**, on the Moon's surface and mapped to the image plane at point, **G**.

Orthographic Projection

Orthographic projection (Figure 6a) is the view an observer has when located at a large distance and is approximately the type of view we have from Earth. The difference now is that it is possible to choose the vantage point and are no longer constrained to view from near the center of the Moon's Earth facing hemisphere. Functionality of this type this can also be found in the program PlanetWarp, available at http://www.astrospider.com/planetwarp.htm.

Figure 7 (p. 14) shows an orthographic projection centered on Copernicus. The view is reminiscent of what we see from Earth but is eerily different. The Moon appears to be at first quarter but Copernicus is already in sunlight. Mare Crisium, normally so prominent on the new Moon's crescent, is barely visible near the limb at the top right of center. It is instructive to compare the images in Figures 7 and 8 with the images of the Moon in Figure 2 which are quite close to the original unprocessed image.

Figure 8 (p. 14) shows the perspective view of a nine-day-old Moon that an observer would have stationed two lunar radii (about 3,500 km) above the crater Copernicus which now looms large. The proximity to the lunar surface means that much less than a full hemisphere is visible. The craters Tycho and Plato sit quite close to the visible horizon and Mare Crisium has vanished beyond it.

Stereographic Projection

Stereographic projection (Figure 6b) has a long history. It was known to the ancient Greeks Hipparchus and Ptolemy but possibly predates them. It appears in the construction of astrolabes. More recently it has played a key role in the representation complex numbers on the so-called Riemann sphere. Stereographic projection has the important property that it is conformal or angle preserving. For this reason it is sometimes employed for making maps of the polar regions. In addition it has the interesting property that circles on the surface a sphere remain circles when mapped by stereographic projection onto a plane[4].

Figure 9 (p. 14) shows a stereographic projection of the Moon centered on the crater Copernicus. Notice that the craters Plato (upper left) and Tycho (lower right) which are normally seen obliquely now show their true circular form. The scale of stereographic

[4] The point at the center a circle on the sphere, however, will not in general be mapped to the center of the circle on the plane.

projection increases with the distance from the center and hence Tycho, which is actually smaller than Copernicus, appears to be larger. Because the center of a circle on the sphere does not, in general, correspond to the center of the circle when mapped onto the plane, central peaks may appear slightly offset. In this view the terminator which was the arc of a great circle passing close to the center of the projection has been transformed into something close to a straight line. ■

Figure 7: Orthographic projection. The view seen by an observer far above the crater Copernicus.

Figure 8: Perspective projection. The view seen by an observer 2 lunar radii above the crater Copernicus.

Figure 9: Stereographic projection of the 9 day old Moon centered on the crater Copernicus. The conformal property of the stereographic projection means features on the Moon's surface show their true shape without any foreshortening as we would normally see.

Figure 3c: Red-Cyan stereo image of the Moon

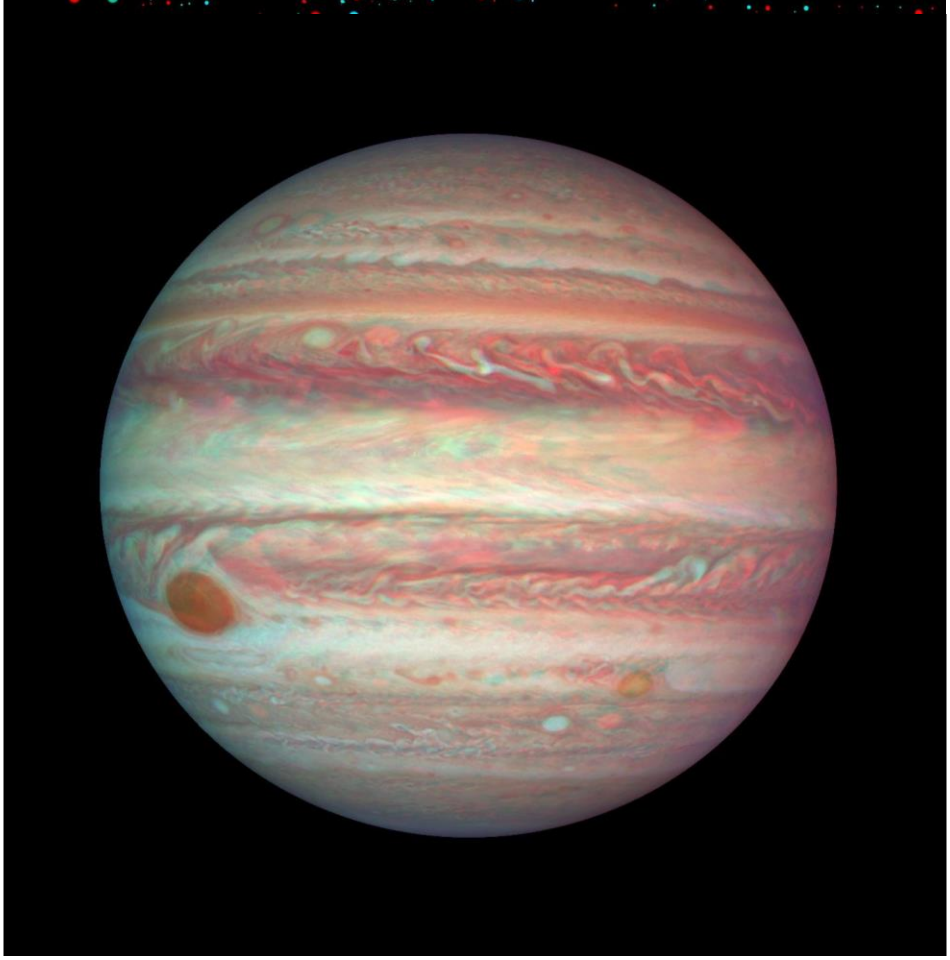
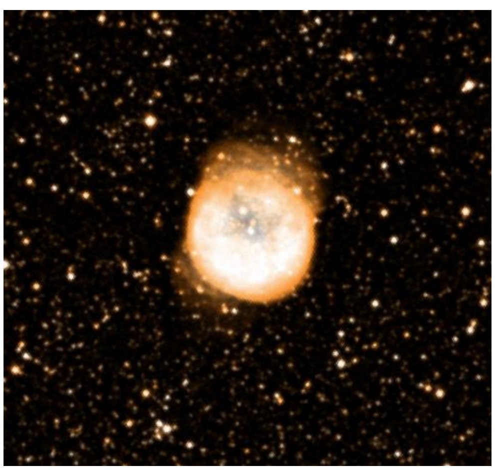


Figure 5c: Red-Cyan stereo image of Jupiter

Images

NGC 6781, Planetary Nebula in Aquila by Gary Miller



Sloane Digital Sky Survey

NGC 6781 is an often overlooked magnitude 11.4 planetary nebula in Aquila. It's small, about 1.8 arc minutes in diameter, and is 3,100 LY distant. Stephen O'Meara calls it the "Ghost of the Moon" (*The Secret Deep*, #90). It was first seen by William Herschel on July 30, 1788. It lies about 8½ degrees west of Altair. Although it looks circular, it is apparently a "butterfly" nebula that we see along its polar axis. The white dwarf central star has a magnitude of 16.2, with an estimated mass of 0.6 Suns ($M_{\odot}$), but its luminosity is 350 times greater than our star. Prior to the explosion that created the nebula, the progenitor star was estimated to have a mass of 1.5 $M_{\odot}$. The blue color is the forbidden line of doubly ionized oxygen (OIII) at 500.7 nm, while the red outer zone is the hydrogen alpha line at 656.28 nm. The red star to the left of center is 14.04 magnitude UCAC4-483-098467, not physically associated with the nebula. Read more about planetary nebulas in the October 2015 SkyWAAtch.

Dave Parmet at Cherry Springs

Our intrepid webmaster David Parmet drove out to Cherry Springs, Pennsylvania on Labor Day weekend. Dave writes:

It was a surprisingly smallish crowd, considering a clear night with a new Moon. The usual crowd of retirees who have the time and money to invest in expensive gear!

The night started out great - I was looking at Saturn through the scope and could clearly see the Cassini division. It stayed perfectly clear and still until around midnight, at which point it got hazy. You could hear the unmistakable sound of telescopes being shut down and tents being zippered up.

Surprisingly enough, my scope never dewed over, even when it started to get hazy.

I looked at M24, M13, M15, M8, M20, M17 (the Sag grand tour!), M27, the Veil (just beautiful in such clear, dark skies), M51 (clear as a bell) and M31.

Definitely the highlight of the night was when a guy set up near me got in his car (which turned on the dome light, which was bad enough) and started it up with the headlights blaring. I thought the other observers were going to come at him with baseball bats.

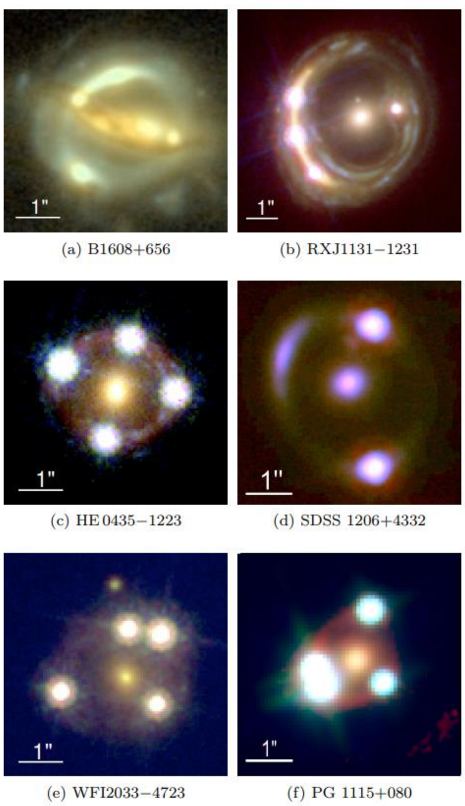
Images:

The Milky Way (top, with many satellites!) is at ISO 13,800, 24mm, ƒ4.5, 30 seconds guided on an AstroTrac mount

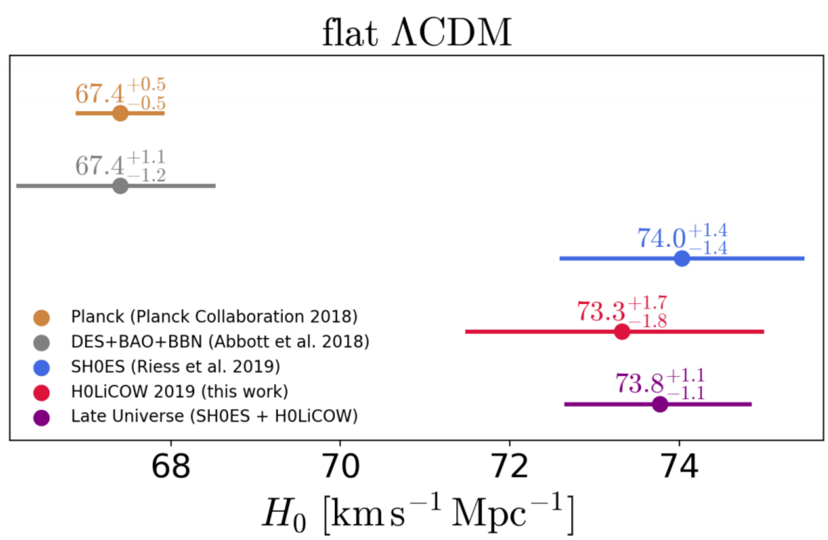
The Summer Triangle (bottom) is at ISO 6400, 24mm, ƒ5.0, 4 minutes guided on an AstroTrac mount

Research Highlight of the Month

One of the hottest topics in astronomy right now is the disagreement in the value of the Hubble constant (H_0, the velocity of the expansion of the universe at the current time) when it is measured using “early” cosmic phenomena such as the cosmic microwave background or baryon acoustic oscillations or “late” phenomena such as distances of Cepheid variables, supernovas and other astronomical phenomena that are relatively recent in cosmic time. “Early” values calculate H_0 to be around 67 km/sec/Mpc while “late” values observe it to be around 74. Astronomers are finding ever more clever ways of determining the value of H_0. In a paper from the H0LiCOW consortium (*H_0 Lenses in COSMOGRAIL’s Wellspring*, COSMOGRAIL standing for *COSmological MOnitoring of GRAvItational Lenses*), an international group measured differential timing of light from gravitationally lensed quasars using the Hubble Space Telescope. This “late” dataset gave a value of H_0 of $73^{+1.7}_{-1.8}$. A recent study by Wendy Freedman using red giant stars in nearby galaxies (also using Hubble) gave a value of 69.8, in between the “early” and “late” data, which further confuses the matter. The “early” determinations depend on accepting the standard ΛCDM model of the universe (4.9% baryonic matter, 25.9% cold [non relativistic] dark matter, 69.2% dark energy, flat geometry, several free parameters), so astronomers are beginning to wonder whether the discrepancies are actually due to new physics (with ΛCDM needing some tweaking). Perhaps the universe is not flat, or dark energy has unexpected properties, such as having an energy density that is time-dependent or an equation of state that is not the currently accepted -1. Maybe there were additional neutrino species in the early universe, or the masses of neutrinos changed over time. As confusing and frustrating as these measurements might be, astronomers are undoubtedly chomping at the bit to unravel the mystery. (LF)



Images of the lensed quasars used in the study (Fig 1 from Wong et. al.)



Data from “early” and “late” era determinations of H_0. The difference between the midpoints of the two ranges has a statistical variance of 5.3 sigma, which means there is a chance of less than one in two hundred thousand that the discrepancy is not real. (Fig 12 from Wong et. al.)

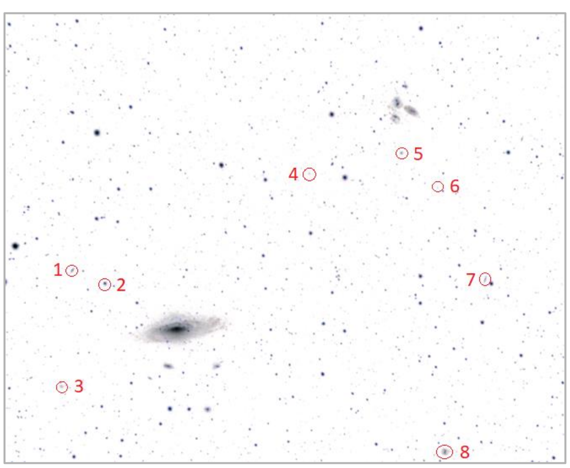
Wong, KC, et. al., H0LiCOW XIII. A 2.4% measurement of H_0 from lensed quasars: 5.3σ tension between early and late-Universe probes, https://arxiv.org/pdf/1907.04869.pdf, posted July 12, 2019.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Celestron 8" SCT on Advanced VX mount	Purchased in 2016. Equatorial mount, portable power supply, polar scope, AC adapter, manual, new condition.	$1200	Santian Vataj spvataj@hotmail.com
Celestron CPC800 8" SCT (alt-az mount)	Like-new condition, perfect optics. Starizona Hyperstar-ready secondary (allows interchangeable conversion to 8" f/2 astrograph if you get a Hyperstar and wedge). Additional accessories: see August 2018 newsletter for details. Donated to WAA.	$1000	WAA ads@westchesterastronomers.org
Explore Scientific Twilight I Mount	Manual Alt/Az, capacity 18 lb. Steel tripod. Excellent condition. Used fewer than 10 times. Great for grab-and-go viewing. Owner upgrading to an EQ mount.	$110	Eugene Lewis genelew1@gmail.com
Celestron StarSense autoalign	Brand-new condition in original packaging. Accurate auto-alignment. Works with all recent Celestron telescopes (fork mount or GEM). See info on Celestron web site. Complete with hand control, cable. Only smaller mount bracket is included (fits in finder shoe). Printed documentation. List $359. Donated to WAA.	$175	WAA ads@westchesterastronomers.org
Meade 395 90 mm achromatic refractor	Long-tube refractor, f/11 (focal length 1000 mm). Straight-through finder. Rings but no dovetail. 1.25" rack-and-pinion focuser. No eyepiece. Excellent condition. A "planet killer." Donated to WAA.	$100	WAA ads@westchesterastronomers.org

Want to list something for sale in the next issue of the WAA newsletter? Send the description and asking price to ads@westchesterastronomers.org. Member submissions only. Please submit only serious and useful astronomy equipment. WAA reserves the right not to list items we think are not of value to members.

Buying and selling items is at your own risk. WAA is not responsible for the satisfaction of the buyer or seller. Commercial listings are not accepted. Items must be the property of the member or WAA. WAA takes no responsibility for the condition or value of the item or accuracy of any description. We expect, but cannot guarantee, that descriptions are accurate. Items are subject to prior sale. WAA is not a party to any sale unless the equipment belongs to WAA (and will be so identified). Sales of WAA equipment are final. Caveat emptor!



Faint Galaxies on Gary Miller's Cover Image

	Object	Magnitude
1	PGC 69281	15.7
2	NGC 7325	15.3
3	PGC 2051985	16.1
4	PGC 141039	17.9
5	NGC 7320C	15.2
6	PGC 141041	16.1
7	PGC 69346	15.7
8	NGC 7343	13.1