The High Desert Observer

May 2019

The Astronomical Society of Las Cruces (ASLC) is dedicated to expanding public awareness and understanding of the wonders of the universe. ASLC holds frequent observing sessions and star parties and provides opportunities to work on Society and public educational projects. Members receive the *High Desert Observer*, our monthly newsletter, plus membership to the Astronomical League, including their quarterly publication, *Reflector*, in digital or paper format.

Individual Dues are $30.00 per year

Family Dues are $36.00 per year

Student (full-time) Dues are $24.00

Annual dues are payable in January. Prorated dues are available for new members. Dues are payable to ASLC with an application form or note to: Treasurer ASLC, PO Box 921, Las Cruces, NM 88004. Contact our Treasurer, Patricia Conley (treasurer@aslc-nm.org) for further information.

ASLC members receive electronic delivery of the HDO and are entitled to a $5.00 (per year) Sky and Telescope *magazine discount.*

ASLC Board of Directors, 2019

Board@aslc-nm.org

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Masthead Image: February 10, 2017 From Las Cruces, Moon rising over the Organ Mts in Penumbral Eclipse.

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May Meeting --

Our next meeting will be on ***Friday, May 24***, at the Good Samaritan Society, Activities Meeting Room at 7:00 p.m.

The speaker will be Vandy Starkweather. Her topic will be Preserving New Mexico's Enchanted Dark Skies.

Member Info Changes

All members need to keep the Society informed of changes to their basic information, such as name, address, phone number, or emai address. Please contact Treasurer@aslc-nm.org with any updates.

Events

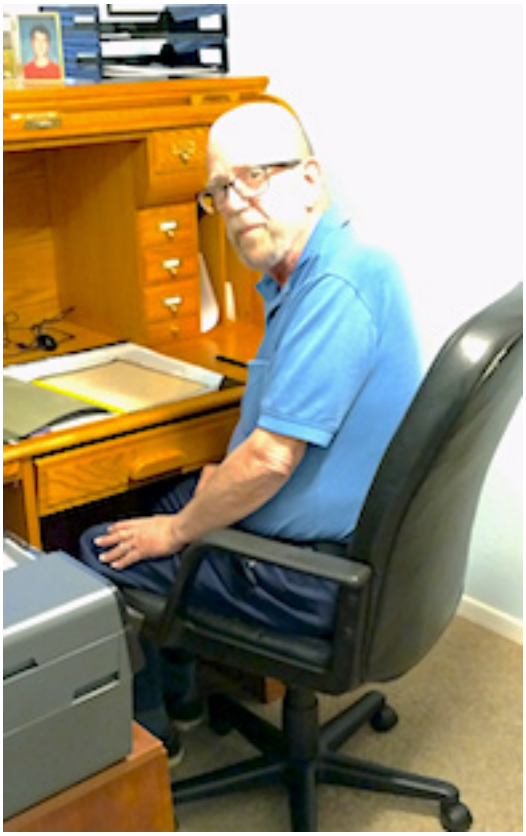
ASLC hosts deep-sky viewing and imaging at our dark sky location in Upham. We also have public in-town observing sessions at both the International Delights Cafe (1245 El Paseo) and at Tombaugh Observatory (on the NMSU Campus). All sessions begin at dusk.

At our Leasburg Dam State Park Observatory, we hold monthly star parties. Located just 20 miles north of Las Cruces, our 16" Meade telescope is used to observe under rather dark skies.

Please see *Calendar of Events* for specific dates and times.

From the President's Desk

May 2019



As we pointed out in an earlier article LIGO came back online April 1st. Boy has it been busy. In just one month it has already made five potential sightings. Not bad when you consider that it took decades to find the first set of ripples in spacetime. For the first time the two observatories, LIGO and Virgo (based in Italy) are announcing candidates as they are discovered so the five may not all be true gravity waves. The findings will need to be confirmed. Most events are from black holes merging and some from the merging of neutron stars. By far the most interesting of the latest sightings is a possible merger of a black hole and a neutron star. It will be very interesting to see what the final verdict will be.

Our speaker this month will be Vandy Starkweather. Her talk is titled Preserving New Mexico's Enchanted Dark Skies, a subject in which she is very well versed. Vandy and her husband Gary, moved to New Mexico from Florida to do astronomy. They live in the astronomy community 20 miles north of Deming. It is also a topic about which we who enjoy the universe beyond our atmosphere need to be concerned.

THE ANSWER IS 42!

Tracy Stuart, ASLC President May 2019

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Outreach
Outreach is a very important part of ASLC. We are always looking for more volunteers to help us educate the public. Even if you do not have a portable telescope to bring to the events, please consider attending our public outreach programs to help answer questions, share knowledge and point out objects in the sky.

Outreach Events
2019 April Report by Jerry McMahan

Friday, April 12th

Several events were scheduled for the same day. Jerry McMahan, Steve Wood, Steve Barkes and Ed Montes volunteered for the night time event at Dripping Springs. A solar event was scheduled for Highland Elementary. Steve Shaffer, Howard Brewington and Tracy Stuart were going to bring solar scopes. Steve Shaffer was going to handle open house at Tombaugh Observatory by himself.

Since I usually attend all events so that I can report on them, I had to figure out a way to be at three places at the same time. I had an idea for accomplishing this, but it fell through when I realized that the community college was not the same as Hogwarts.

Plan B was call in clouds to cancel the events. Plan B worked. Steve Shaffer did go to the elementary school, but clouds did result in all three events being canceled.

Moongaze, Saturday, April 13

We usually have two sites for Moongaze, the International Delights and Pan Am Plaza. Chuck Sterling was on his way to visit his daughter in California, so it was decided that everyone would go to Pan Am Plaza.

Steve Wood brought his 8 inch Celestron. Howard Brewington set up his 8 inch Dobsonian. Ed Montes had his 50mm refractor. I brought the ETX 125. Weil, I sort of brought the ETX. It was in the car, but I forgot the tripod, so I wasn't able to set it up.

At first I thought Ed was just trying to make me feel better about forgetting the tripod. He said he recently forgot an appointment a few days ago and forgot another appointment that had not happened yet. He forgot something in the past and he forgot something in the future. Think about it people! It is obvious. Ed is a time traveler!

Even with my failure, we had a successful outing. It was cloudy in the North, but clear overhead. The Moon was very high in the sky. It was almost at the zenith. Ed gave people of the Pleiades (445 years in the past) a lecture on the Moon.

Bright Beginnings Pre School, Tuesday. April 22

I was not able to attend this event, Steve Wood, the reporter at the scene, filled me in about this day time event. It was a solar scope event from 10:30 AM until noon. Steve, Tracy Stuart and Howard Brewington participated.

Steve said that the observers were mostly about 5 years old. The most common result was "Don't touch the telescope." GRAB!

Leasburg Dam State Park, Saturday, April 27, 2019

Chuck Sterling operated the 16 inch. I assisted. Steve Wood set up the 11 inch Celestron. Ed Montes brought his 50mm refractor. A lady named Mo, from T or C had a 6 inch Schmidt. Tim was using a 105mm refractor. Sorry Tim. I will learn your last name. I did learn Sam Sterlng's name in less than 50 years.

Dal and Nancy Jones came in from El Paso again. They have become regular participants. Maybe I can talk them into joining the club.

It was a clear night good seeing and good sky transparency. I could see spiral arms in the galaxy M81. We had a very good outing and stayed out an extra hour, or so.

City Of Rocks SP, Saturday, April 27

The weather looked very promissing all day at CoR and fortunately, it did turn out to be a very good night. Even the seeing was good.

We had a very active and animated crowd of 70 to 75 people, mostly adults, but some kids from a Cub Scout group and some others. In fact, when I arrived at sunset, there were already 45 people sitting around the observatory waiting for the program to start! It wasn't easy containing the potential riot.

Mike Nuss handed out our loaner red flashlights while I talked about how not to blind everyone with your million candlepower LED flashlight. I also covered dark adaption and why it is important, plus how to look through a telescope and other practical topics.

Bill Nigg did the main presentation and constellation tour. MIke Nuss manned the 14 inch Meade in the observatory, with assistance from Jan Farnum, a visiting amateur astronomer from El Paso. Charles Turner brought two 6 inch telescopes and Bill brought a small telescope to entertain our guests with views of the heavens. Mike had a very difficult time with the Meade 14. We just bought a new hand control from our donation money, and it was not working. Mike thought he did something wrong or the new hand control just did not like him. Turns out we were zapped by the dreaded GPS Rollover Bug(see the item in the Announcements section for more details.

We viewed many prominent objects because the conditions were good. We could have covered more but the lines were so long that it took a while for everyone to get a look at whatever was currently centered. I gues this fair weather astronomy requires more telescopes!

A good time was had by all and we went home exhausted.

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Calendar of Events (Mountain Time - 24 hr. clock)

May	01	19:53	Sun Sets
	01	23;03	Mars Sets
	01	23:03	Jupiter Rises
	04	16:46	New Moon
	04	19:45	OUTREACH; NPO Program at Rockhound SP, M. Nuss, B. Nigg, C. Turner
	10	21:00	OUTREACH;Tombaugh Observatory Open House: 9:00 PM to 10:00 PM
	11	19:12	First Quarter Moon
	12	20:00	OUTREACH; MoonGaze, International Delights Café
	12	20:00	OUTREACH; MoonGaze, Pan Am Plaza on University Ave
	18	15:10	Full Moon
	23	10:30	OUTREACH, Solar Star Party for Bright Beginnings: 10:30 to 12:30
	24	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room
	25	20:00	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	25	20:00	OUTREACH; NPO Program at City of Rocks SP, B. Nigg, M. Nuss
	26	10:34	Last Quarter Moon
Jun	01	20:09	Sun Sets
	01	22;23	Mars Sets
	01	20:43	Jupiter Rises
	01	22:45	Saturn Rises
	01	20:30	OUTREACH; NPO Program at Rockhound SP, M. Nuss, B. Nigg, C. Turner
	03	04:02	New Moon
	08	20:30	OUTREACH; MoonGaze, International Delights Café
	08	20:30	OUTREACH; MoonGaze, Pan Am Plaza on University Ave
	09	23:59	First Quarter Moon
	10	10:00	Jupiter at Opposition
	11	21:33	Jupiter Multiple Moon Transit, Io and Ganymede, Alt= 16°
	17	02:30	Full Moon
	21	09:54	Summer Solstice
	22	20:30	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	22	20:30	OUTREACH; NPO Program at City of Rocks SP, B. Nigg, M. Nuss, C. Turner
	25	03:46	Last Quarter Moon
	28	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room

Be sure to visit our web site for ASLC information: www.aslc-nm.org

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Announcements

1. The May ASLC meeting will be held on May 24, 2019 at 7:00 PM at the Activities Meeting Room, Good Samaritan Society Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, New Mexico. The program for the May meeting will be a presentation by Vandy Starkweather. Her topic will be about Preserving New Mexico's Enchanted Dark Skies..

2. The agreement to use the facilities at Good Sam for our meeting prohibits members from bringing in ANY food or beverages, except water in a container with a screw lid. Take note: no more Starbucks or Saturn Cookies!

3. The GPS Rollover: We had problems with the Meade GPS telescoope at City of Rocks at the April presentation. It was not anything that we did or failed to do. I hope that one of the techies in our group can explain this better than I can at the next meeting. As I understand it, the GPSs sold by Meade, Celestron, and many other companies had some design compromises to save money by using less memory. When the GPS in the telescope receives a signal from the GPS in the sky, it has to de-code it and calculate the current time and location. There is a code for the week that is a number from 0001 to 1024. After 1024, the GPS has to Roll Over because there is not enough memory to count to 1025! The end result is that the GPS in the telescope gets confused and cannot figure out what is the correct time and location. The Meade telescopes seem to think it is 2099 and they go haywire. I have heard reports that Celestron scopes with built-in GPSs also have problems. The reason that I am mentioning this here is that Meade actually posted a "fix" on their website. However, in their haste to appear responsive to customers, they did not properly test the "fix" and the result is that the fix is worse than the problem. Before you install anything from Meade or Celestron, read the experiences of others to be sure that it actually works. In the meantime, there is a simple caveman fix - Turn OFF the GPS. This will force the telescope to ask for you to input the correct time and location. It only takes a couple of extra minutes, but it will save you a lot of grief until there is a Proper Fix.

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Meeting Minutes
ASLC Monthly Meeting
April 2019

Show and Tell:

There were no items or topics offered at tonight's Show & Tell session.

Call to Order:

Tracy Stuart, President, called tonight's meeting of the Astronomical Society of Las Cruces (ASLC, the Society), to order at 7:00 pm on 26 April 2019, in the downstairs Conference Room, Good Samaritan Society Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, New Mexico.

President's Comments:

Tracy welcomed the group to tonight's meeting and noted this month's meeting was being held in the Conference Room rather than the Creative Arts Room to accommodate the Good Samaritan Society annual garage sale. Next month's meeting should be back in the Creative Arts Room. The minutes for the March meeting were published in the April High Desert Observer (HDO), the Society's newsletter. Tracy asked if there were any changes or corrections required. Ed Montes moved the March meeting minutes be accepted as published in the HDO, Kim Morgan seconded. The minutes were accepted by acclamation.

Treasurer's Report:

Trish Conley, Treasurer, provided a summary of the Society's finances. The Society had a net income of $65.91 for the 1st quarter of 2019 and $284 so far for the 2018-2019 fiscal year.

Outreach:

Chuck Sterling, Program Coordinator, announced upcoming events. There will be a 3rd quarter Moon event at Leasburg Dam State Park (LDSP) on 27 April. The Texas Star Party (TSP) at Ft. Davis, TX, starts next week. There will be an open house (the last for this school year) at Tombaugh Observatory on 10 May. There will Moon Gazes at two locations, International Delights Café and El Milagro Coffee y Espresso, on 11 May. Another 3rd Quarter Moon event will be at LDSP on 25 May.

New Business:

1. Tracy received a query about any pictures of Lyle Puntney, Society Treasurer in the 60's and 70's. Vince Dovydiatis may have some.

2. The Great Southwest Star Party will be held at the Space Hall of Fame/New Mexico Museum of Space History in Alamogordo May 31 – June 02.

3. Charles Turner reported on star parties supported in the Deming area by Society members. All members are welcome to participate.

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Presentation:

April's presentation was by Dr. David Lee Summers on the Dark Energy Spectrographic Instrument (DESI) being installed at Kitt Peak National Optical Astronomy Observatory (NOAO) in Arizona and its five-year mission to survey the northern sky and better understand the nature of dark energy. David is an astronomer who has worked as a telescope operator at Kitt Peak over the past decade. He has also worked at such sites as Apache Point Observatory and the Very Large Array in New Mexico. Over the last year, he has been supporting the installation of the new DESI at Kitt Peak's Mayall 4-meter observatory and has just started re-commissioning the telescope after the year-long refit. When he's not working at the observatory, David lives in Las Cruces with his family and is a professional science fiction writer. His novels explore everything from solar sails to haunted observatories and even glimpse at the Mesilla Valley's past.

The April meeting of the Astronomical Society of Las Cruces concluded at 8:20 pm. A social time followed at Pecan Grill.

-Respectfully submitted by John McCullough, ASLC Secretary

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In Case You Missed it, News from the Heavens
May 2019 - By Kevin Brown

ESO Discovers Earth-size Planet in Habitable Zone of Nearest Star

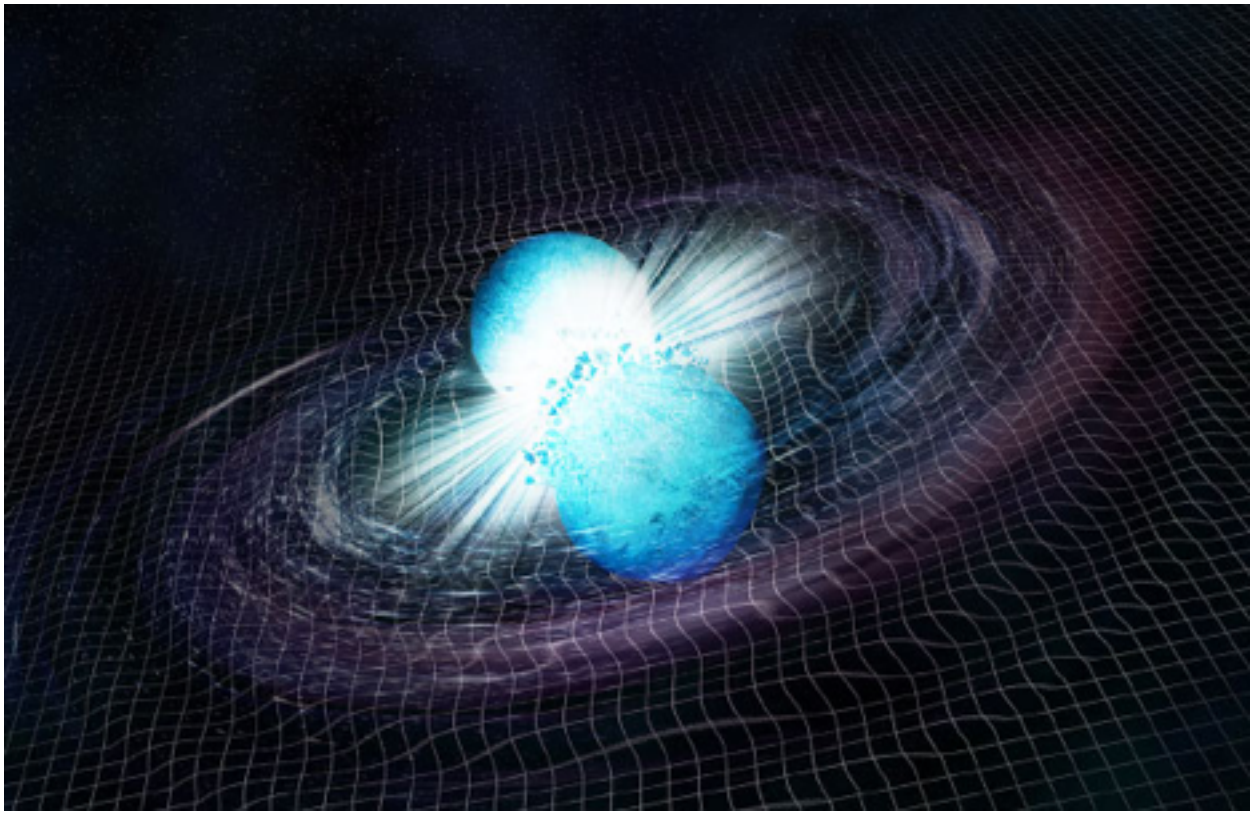
A team of astronomers using the European Southern Observatory's 3.6 meter telescope in Chile discovered a roughly earth-size rocky planet orbiting within the habitable zone of red dwarf star Proxima Centauri. It is estimated to have a mass of 1.3 Earths. At just over 4 light-years away Proxima Centauri is the closest star to earth except for our sun. Although the exoplanet orbits its star more closely than Mercury orbits our sun, taking 11 days to complete one orbit, the fact that Proxima Centauri is a red dwarf far smaller and cooler than our sun means that it is within the zone where the temperature is suitable for the existence of liquid water on the surface. However the announcement came with caveats. Although the new exoplanet is within the habitable zone it probably presents only one face to the star as the Moon does to earth and the scientists do not yet know whether it has an atmosphere.

First Image of a Black Hole

An international network of radio telescopes called the Event Horizon Telescope has captured the first ever image of a black hole. The image shows the shadow of the black hole surrounded by a disk of hot material at the center of the elliptical galaxy M87 approximately 55 million light-years from earth. Capturing this image involved the use of eight ground-based radio telescopes around the world operating together as if they were one telescope the size of our planet. The black hole has a mass of 6.5 million Suns. A jet of high energy material extending more than 1,000 light-years away from the center of M87 was first noticed by astronomer Heber Curtis in 1918.

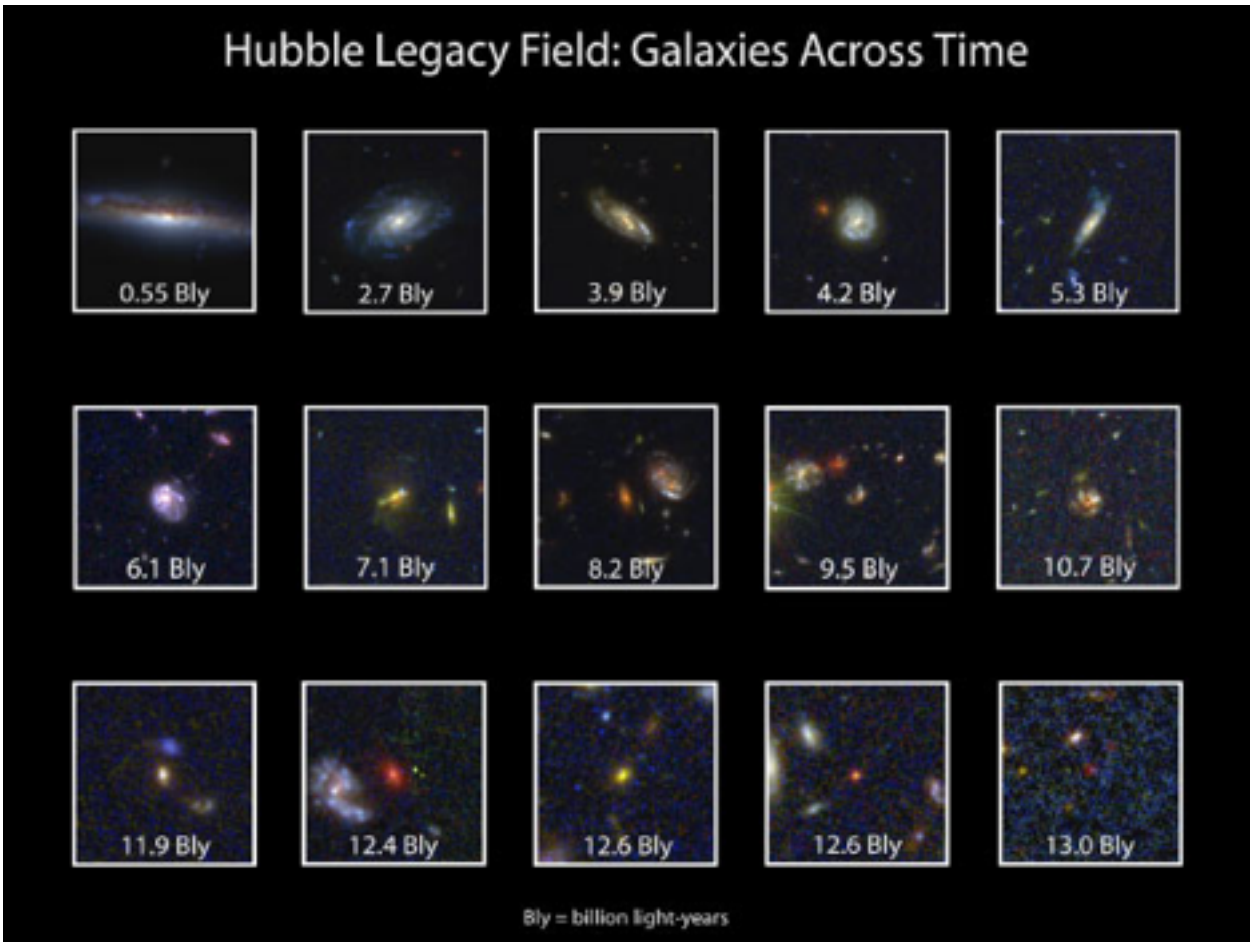
LIGO and Virgo Observatories Detect Two New Gravitational Waves

Two new gravitational waves, the ripples in space-time predicted by Albert Einstein, were detected by the LIGO and VIRGO observatories on April 25 and 26, 2019. The first was from a collision of two neutron stars approximately 500 million light-years away. The second was from a neutron star being swallowed by a black hole at a distance of approximately 1.2 billion light-years. If the second event is confirmed it will be the first of this kind to be detected. LIGO consists of twin detectors in Washington and Louisiana and Virgo is located at the European Gravitational Observatory in Italy. They both had resumed operation on April 1, 2019 after undergoing upgrades to increase their sensitivities to gravitational waves.



Hubble Legacy Field Image

For all of you imagers, astronomers using 16 years' worth of observations from the Hubble Space Telescope have produced the largest and most comprehensive 'history book' of galaxies. The above mosaic image is a combination of almost 7,500 separate Hubble exposures and contains roughly 265,000 galaxies that stretch back through 13.3 billion years of time. The Hubble Legacy Field combines observations from the 1995 Hubble Deep Field, the 2004 Hubble Ultra Deep Field, and the 2012 Hubble eXtreme Deep Field. Below are close-up images of 15 of the 265,000 galaxies in the Hubble Legacy Field that span the evolution of galaxies through time.



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The Uranograph - May 2019.

By Bert Stevens

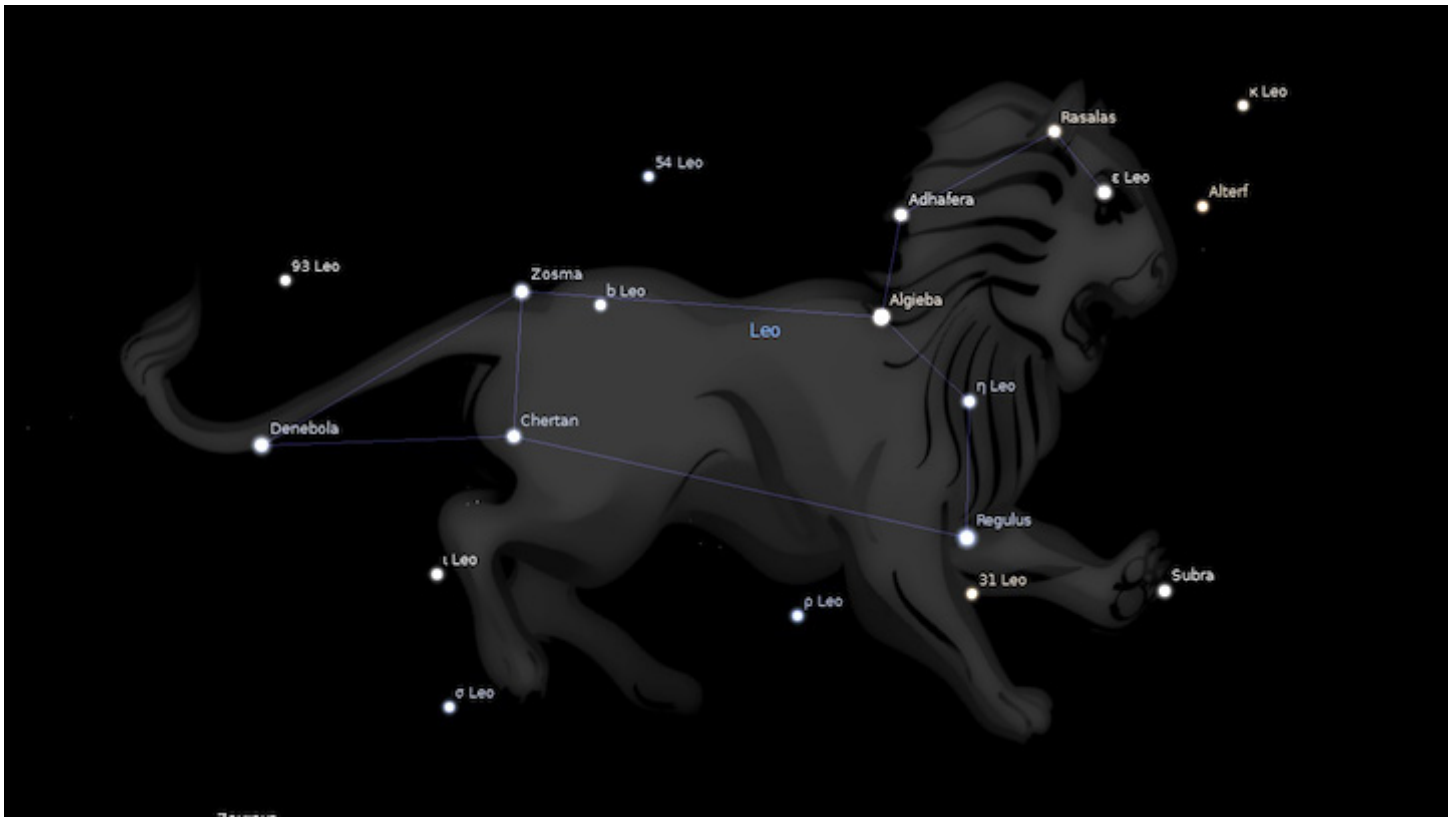
Constellation of the Month: Leo the Lion.

The constellation for this month is Leo, the Lion. While we take this grouping of stars as a lion from the Greek mythology, many other ancient civilizations including the Turks, the Syrians, the Jews, the Egyptians, the Sumerians and the Babylonians also saw this asterism (grouping of stars) as a lion.

In Greek mythology, Leo represents the Nemean Lion. This creature was suckled by the goddess Selene (the Moon), and it was a favorite of the goddess Hera. The Lion traveled from the Moon to the Earth as a meteor. Landing in Nemia, a valley in southeastern Greece, near Corinth, the Lion tore across the countryside, wreaking havoc everywhere it went. Its hide was so thick that none of the Corinthian's weapons could penetrate it.

Here is where the great Hercules enters the scene. His first Labor as assigned by his cousin Eurystheus, the king of Tiryns and Mycenae, was to kill the Nemean Lion. With the Lion so feared by the local folk, they knew where it was and told Hercules where to find it. The fearless Lion came out of its cave and Hercules immediately shot an arrow at the Lion's heart. Even with Hercules' great strength behind the arrow, it was not enough to penetrate the skin of the Lion and the arrow just bounced off the Lion's hide. Hercules now knew that even his strength would not be enough to bring down the Lion.

Hercules now set out to kill the animal "by hand". He knew the Lion's cave had two entrances, and he did not want it to escape, so he first sealed off one of the entrances. Hercules now chased the Lion into its lair through the other entrance. The Lion could not escape past Hercules and when it discovered the other entrance was blocked, the Lion turned to face Hercules. Knowing he could not penetrate the creature's skin, Hercules used his enormous strength to ram his fist down the Lion's throat, strangling it.



The Constellation of Leo the Lion with bright stars marked.

To prove he had completed his first Labor, Hercules flung the carcass of the Lion over his shoulder and carried it back to King Eurystheus. Seeing Hercules with the Lion's carcass, the fearful King hid himself in a storage jar and from there issued Hercules his next Labor. Hercules made the Nemean Lion's skin into an impenetrable cloak with the head and gaping jaws as a helmet.

On Olympus, the goddess Hera was greatly angered at the destruction of her favored creature. She raised the soul of the Lion into the sky where it became the constellation Leo, the Lion.

Leo is a fairly large constellation, stretching some 37 degrees from nose to tail. When you take a look at Leo in the sky, the most striking feature is the backwards question mark that makes up his mane and head. The period at the bottom of the question mark is Regulus, the brightest star in Leo. While it is the brightest in Leo, Regulus is the faintest of the traditional "first magnitude" (brightest) stars in the sky, shining at magnitude +1.40.

Regulus is actually a quadruple star system. The primary is magnitude +1.35, a blue-white main sequence star with a spectral class of B7. It is 3.8 times the mass of our Sun, giving out 288 times as much energy as our Sun. It rotates amazingly fast, taking just 15.9 hours to make one turn. This makes it very oblate, a squished sphere.

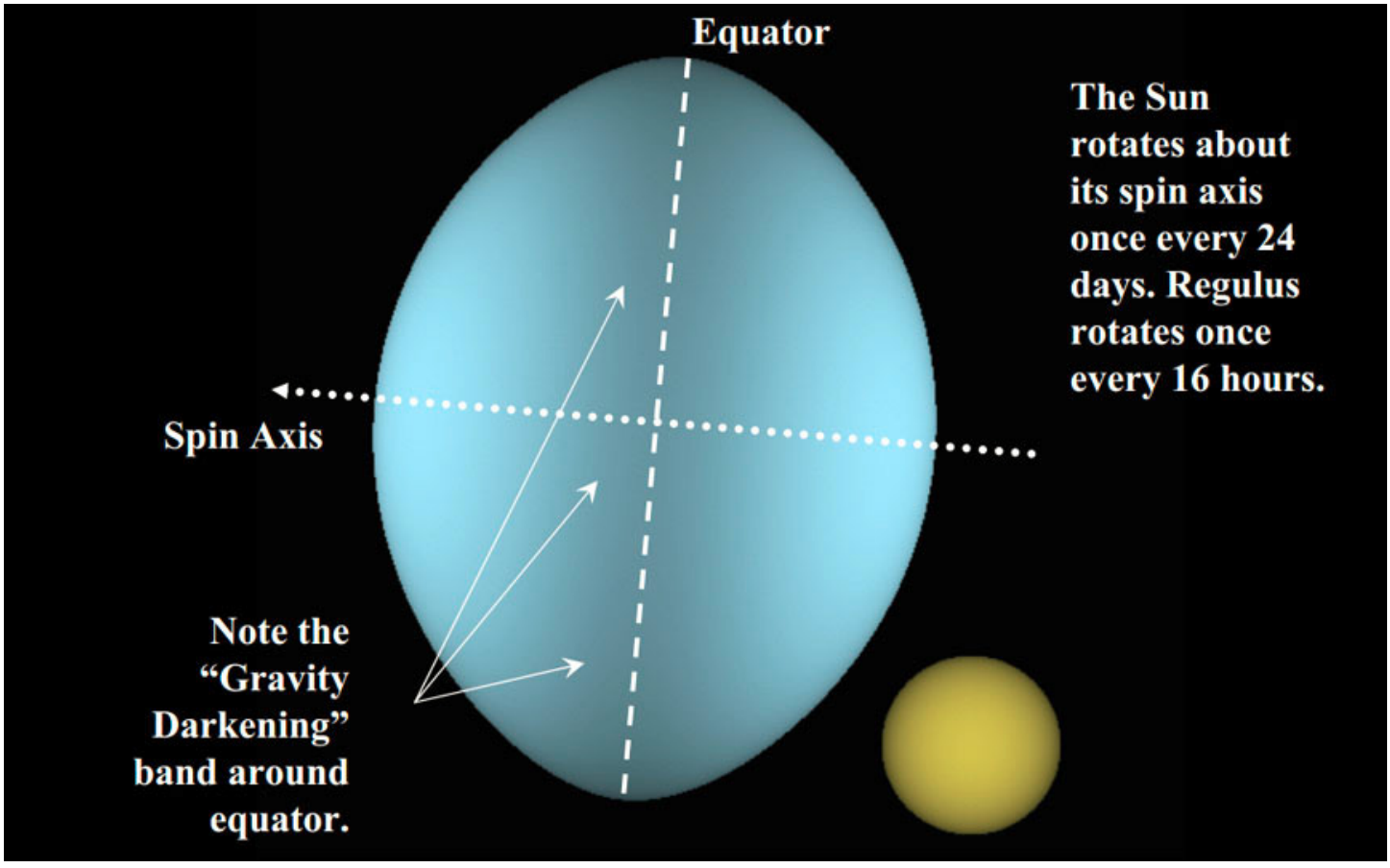


Diagram 1: The bright star Regulus.

Since the poles are substantially closer to the center of the star than the equator, gravity is stronger at the poles than at the equator. This makes the surface at the poles hotter and brighter than the surface at the equator, making the poles "gravity brightened" while the equator is "gravity darkened".

This oblate shape also has an effect on the orbit of its white dwarf companion. It is no longer a simple two-body problem to compute the motion of the secondary which is perturbed by the bulge. The white dwarf companion is at least 0.3 solar masses, which has never been observed. It was originally thought that Regulus A was only 50-100 million years old based on its size and composition, but the existence of an old white dwarf means it must by over a billion years old.

Regulus A camouflaged its age by stealing mass from its companion star before the companion became a white dwarf. As the secondary aged and became a red giant, the primary was able to siphon off mass from the secondary's now expanded atmosphere. This made the primary grow in mass, making it look younger.

A higher mass star leaves the main sequence at a younger age. Since Regulus spent much of its life as a lower mass star, it can stay on the main sequence longer as it continues to fuse hydrogen into helium. With the additional mass from the secondary, this star will now age more quickly than it would have otherwise. It is larger and brighter, but will die much sooner than it would have if it had not taken on mass from the secondary.

Regulus has another pair of companion stars, Regulus B and C. Regulus B is spectral class K2 with a mass of 0.8 Suns, while Regulus C is spectral class M4 and it has a mass of just 0.3 Suns. Both are still on the main sequence. They are located around five thousand astronomical units from the primary, which is 2.5 seconds-of-arc in the sky. They take about six hundred years to orbit Regulus A.

Another star near Regulus, Regulus D, is a 12th magnitude star some 212 seconds-of-arc from the primary, but it is apparently an unrelated background object. So while Regulus shines in Leo like any other star, it hides mysteries and surprises for those of us who enjoy the celestial show!

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Set Screw Upgrade by Bill Nigg

Those Chinese little finger screws that hold all the small stuff together have a limited lifetime and may end in a possible surprise failure event. The chrome threads wear out and we keep tightening them for adequate attachments. Then they bail out in the dark and your prize eyepiece or camera takes a dive. You are probably done for the night with that stuff. (swear words)

I have replaced all of them with #10-32x1" SS machine screws with external tooth star washers and a tight nut. This gives lasting performance and can even be used with gloves. You may place 3 of them 120 degrees apart for bettering centering. The star washer sticks out just enough for finger traction. This means that you have to drill out the receiving holes and tap them for #10-32. Any high school shop class can do it for you if you are a non-shop person. Don't try it if you can't accurately drill at 90 degrees with stability and have never "tapped" before. Somebody in the club can show and help you.

Proper tools include: #21/0.159 drill bit, #10-32 tap and handle (I use a 3 flute), Tap Magic aluminum lube, drill press, press vice, and bench vise to assemble with screwdriver with patience. You will gain confidence that your expensive components are safer and can have a few spares in the eyepiece case.

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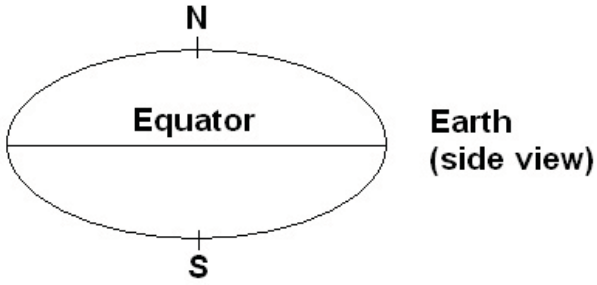
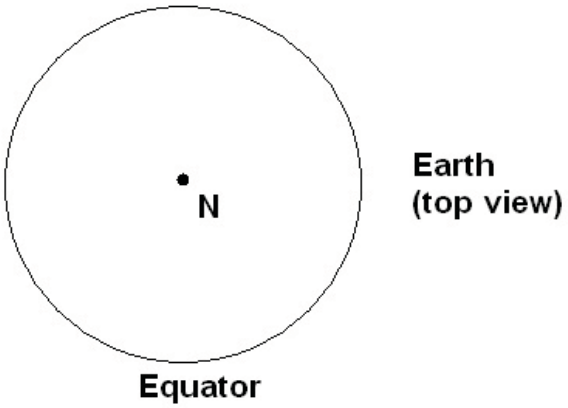
#1 Where on Earth?

This is the first in a series of articles designed to help those with a personal computer to write their own satellite prediction program. This first article shows how to determine the location of a point on an elliptical Earth given longitude and latitude. The location will be given in an x-y-z inertial coordinate system which later will be useful in determining what satellites can be seen at a given time.

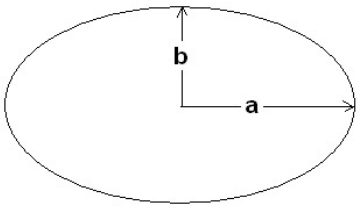
A satisfactory model of the Earth is that of an ellipse. Because the Earth is spinning it bulges at the equator and flattens at the poles. Planes intersecting the Earth parallel to the plane of the equator produce circles. Planes intersecting the Earth through the spin axis produce ellipses.



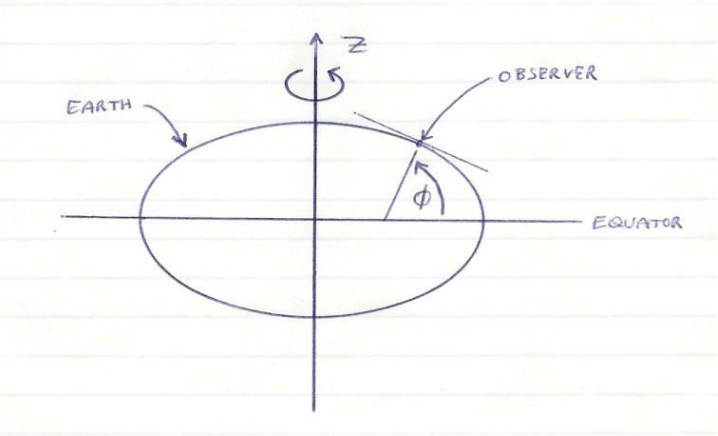


A term which shows up often in the literature is “flattening” or f.

$$f = \frac{a-b}{a} \cong \frac{1}{298.25} \quad for\,Earth$$

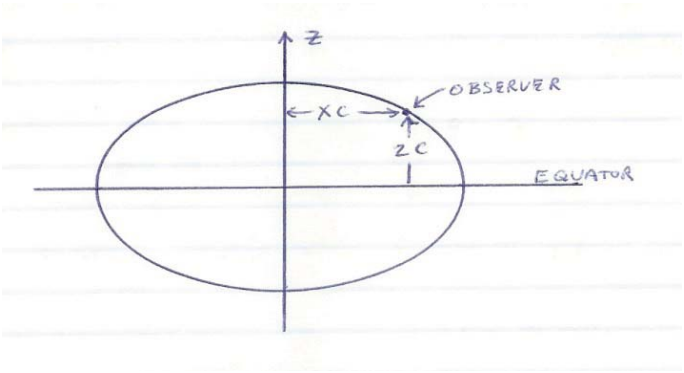


Geodetic Latitude is the angle between a line normal to a tangent plane touching the reference ellipsoid and the equatorial plane.



Φ = Geodetic Latitude

The geodetic latitude is the one that we are all familiar with. This is given on maps as "the latitude." What we want are the two numbers XC and ZC. XC is the distance from the Earth's spin axis and ZC is the distance from the equatorial plane.



$$XC = \left[\frac{R_{\oplus}}{\sqrt{1-(2f-f^2)\sin^2(\phi)}} + H \right] * \cos(\phi)$$

$$ZC = \left[\frac{R_{\oplus}(1-f)^2}{\sqrt{1-(2f-f^2)\sin^2(\phi)}} + H \right] * \sin(\phi)$$

$R_{\oplus} = 6378.16\ km$, H = altitude above sea level (km), f = 0.0033529

The derivation of these equations can be found in "Modern Spacecraft Dynamics & Control" by Marshall H. Kaplan, published by John Wiley & Sons. (Chapter 7)

For example, find XC and ZC for Abilene, Texas.

Latitude = 32° 27’ and altitude = 1710 feet.

$$\phi = \frac{\left(32 + \frac{27}{60}\right)}{57.29578} = 0.566359 \; radians$$

$$\sin(\phi) = 0.536563 \qquad \cos(\phi) = 0.843860$$

H = 1710 feet = 0.521208 km

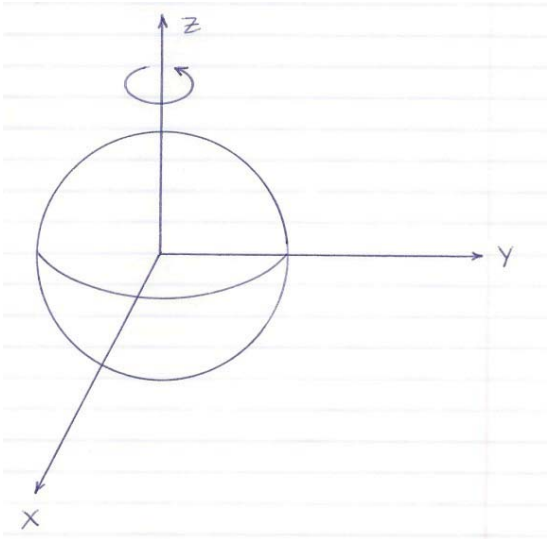
$$XC = \left[\frac{6378.16}{\sqrt{1 - 0.00669454 * 0.536563^2}} + 0.521208\right] * 0.843860$$

$$ZC = \left[\frac{6335.46}{\sqrt{1 - 0.00669454 * 0.536563^2}} + 0.521208\right] * 0.536563$$

XC = 5387.91 and ZC = 3402.94

Compare these numbers to those of a round Earth (f = 0) and you will find an error of over 20 km.

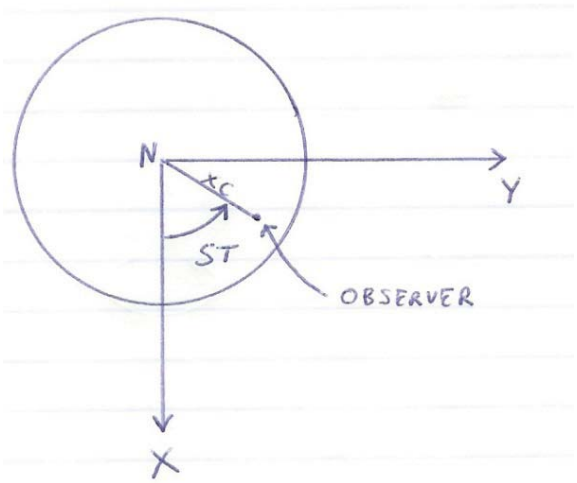
Now that we have XC and ZC we can calculate x, y, and z in an inertial coordinate system. The coordinate system used has the z-axis the same as the Earth’s spin axis. Positive z is north. The x and y axes are both in the equatorial plane. The x axis points to a point in the sky which is where the Sun is on the first day of spring. The y axis is 90° east of the x axis.



Immediately we can calculate z = ZC. If we knew ST (the angle depicted below) we could calculate

$$x = XC * \cos(ST) \qquad y = XC * \sin(ST)$$

Top View of the Earth



The angle ST travels at uniform speed from 0° to 360° each 23.93447 hours, the time required for the Earth to rotate once.

$$ST = (0.27401068 + 0.00273790886 * JD + T / 23.93447) * 2\pi$$

in radians for an observer at 0° longitude. JD and T are described below.

JD is the number of days since December 31st, 1955. T is the number of hours since midnight (GMT).

JD can be found from MO, DA, YR (month, day, year) using this BASIC algorithm:

```
JD = DA + INT(30.56*MO-30) + (YR-1956)*365
JD = JD + INT((YR-1953)/4)
IF MO > 2 THEN JD = JD - 2
IF MO > 2 AND INT(YR/4) = YR/4 THEN JD = JD + 1
```

Calculate ST this way:

1. Find JD using the above algorithm
2. Find T in hours GMT
3. Find LO = East longitude of observing point (radians)
4. Find ST using this BASIC algorithm

```
ST = 0.27401068 + 0.00273790886*JD + T/23.93447
ST = (ST-INT(ST))*6.283185 + LO
```

then

```
x = XC*COS(ST)
y = XC*SIN(ST)
```

Example: Find x, y, and z for Abilene, Texas on April 17, 1984 at 10:30 p.m. CST.

We already have XC and ZC. Calculate JD

```
JD = 17 + INT(30.56*4-30) + (1984-1956)*365
JD = JD + INT((1984-1953)/4)
JD = JD - 2
JD = JD + 1
```

JD = 10335

Find T = 10.5 + 12 + 6 = 28.5 (add 12 because it is p.m. and add 6 because it is CST)

Find LO = East longitude in radians

Abilene Texas longitude = 99° 44’ West longitude = 99 +44/60 = 99.7333 degrees West longitude.

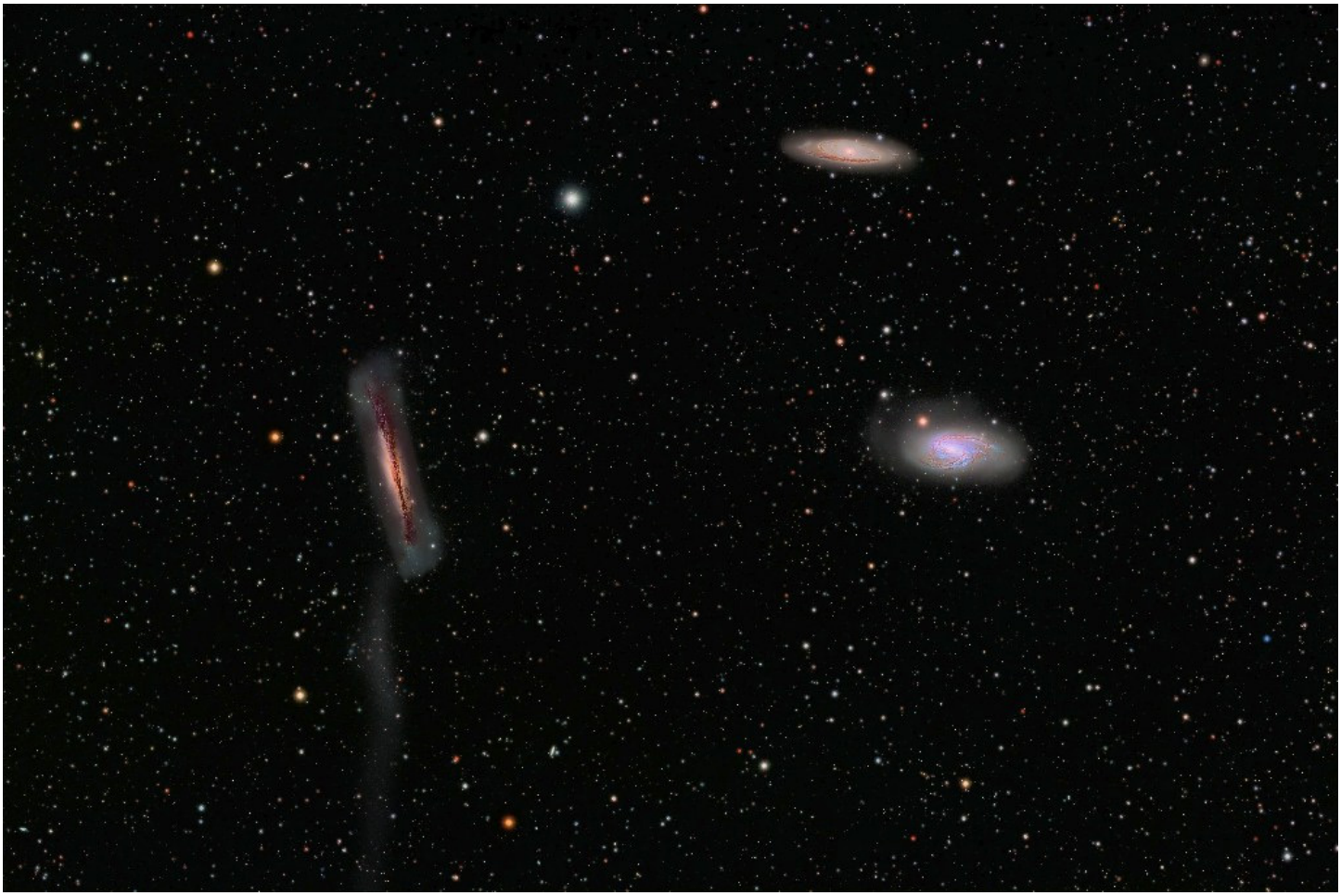
360 – 99.7333 = 260.2667° East longitude

LO = 260.2667 / 57.29578 = 4.54251 radians

```
ST = 0.27401068 + 0.00273790886*10335 + 28.5/23.93447
ST = (ST-INT(ST))*6.283185 + 4.54251
```

ST = 9.32433

```
x = 5387.91 * (-0.994959) = -5360.75
y = 5387.91 * (0.100281) = 540.305
z = 3402.94
```



Leo Triplet (M 65, M 66, NGC 3628)

OTA: Star-Fire 175 (f/8) Camera: FLI - PL16070AE Observatory: Deep Sky West
EXPOSURES (used):
Red: 24 x 900 sec Blue; 14 x 900 Green: 26 x 900 Lum.: 32 x 900
Total exposure 24 hours Image Width: ~1.5 deg

Processed by Alex Woronow using PixInsight & StarNet++ in 2019

The “Leo Triplet” consists of the three spiral galaxies listed in the title. They lie about 35M light-years from us. These galaxies are mutually interacting, gravitationally, which likely accounts for the streamer of gas, dust, and/or stars trailing upward in this picture from the left-most galaxy, NGC 3628. Our edge-on view of NGC 3628 shows a complexly structured medial band of dust and gas obscuring the stars in the plane of the galaxy. M 66 (right-most galaxy) shows a weak barred structure and has an unusually high proportion of its mass concentrated at its center. You should be able to see a faint bulge of material to its right--probably due to its gravitational interaction with NGC 3628. Finally, M 65 is poor in gas and dust (having been stripped in gravitational encounters, I expect) and consequently has little active star-formation (and a dearth of blue stars.)

(Source: largely Wikipedia)

M42 The Great Orion Nebula By Brian Ottum

I've been looking at the Orion Nebula for 45 years, and taking pictures of it for 30 years. This is my best attempt (so far). My goal was to not overprocess, so as to keep it not too far from the visual impression. The Trapezium area is very bright, and hence the same here. The only "fancy" post processing is layering in a shorter exposure of the Trap area. Otherwise, just lots of "curves" in Photoshop.

I'm the "lazy astrophotographer" so I try to keep things as simple as possible. Canon 5DmarkIII (modified) camera on a Taiwanese-made 10" f/5 newt that was optimized for astrophotography. This was one of the last shots I took before upgrading my Paramount MX to a PlaneWave L-350. Total of 4 hours' worth of exposure, in five minute increments.

I'm located near Ann Arbor, Michigan, but the telescope is at Dark Sky New Mexico near Animas. As you may know, this "remote telescope ranch" started out as Rancho Hidalgo. Back in 2014 I installed my rig; and other than the tumultuous change in ownership, it has been a fun ride. My maintenance trips to NM are a joy, especially to escape Michigan's winters. I dabble in selling my stuff, setting up an art show booth at local events. This weekend the local science museum is displaying my big print-on-glossy-metal wall mounts, and I'm teaching astronomy by explaining the objects in my shots. My Instagram account "astropicsdaily" has 22,000 followers where I enjoy interacting with young people around the world.

I've learned a few things about having a remote scope that I can share:

* Get everything set up and running in your own backyard, flawlessly, before even thinking of setting it up a couple thousand miles away.
* On-site help is critical. Some simple things need to get quick attention: roof that won't close ahead of a storm, checking to see why a PC won't reboot, plugging a loose cable back in. Other things can wait a few days but require a lot more skill (installing a router, troubleshooting a balky camera, diagnosing internet connection issues.
* A fast and reliable internet connection is CRITICAL. DSL does not usually cut it. Cell phone connections are costly given the data caps. Current 23,0000 miles out satellite internet has slow latency but OK speeds (OK for a backup). Cable/fiber is required (The low earth orbit satellite constellations might be a godsend in five years.)
* USB is a four letter word. Unreliable technology. I grit my teeth just thinking about the hours spent trying to get cameras, focusers, mounts to connect (culprit can be either software or hardware).
* Do not buy the latest shiny new product and put it where you cannot touch it. It will likely require lots of troubleshooting or just plain fail. New stuff usually does not have a great manual, and is not always pre-tested to ensure it works in your situation. This also pertains to software. Stick to the tried-and-true, reliable.
* Watch out for operating system updates – they tend to put sand in the gears of your smooth-running machine.
* Get a partner or two. This activity is expensive, when you get things running you have more data than one person can handle, and you need to rotate your maintenance trips.
* Many of us astrophotographers sit behind a computer all day and are not used to big physical work. All my partners and I have shed blood out there in the desert. I got dehydrated not once but twice and had to visit ER's a ninety minute drive away. Dumb.

By now, I have imaged all the "greatest hits" available to a medium-focal-length scope. So I'm considering moving the rig to the southern hemisphere where a whole new batch of targets become available. Alternatively, I could partner with others and use their rig.

I'm happy to share my experience or answer any questions folks may have.

Brian D. Ottum, Ph.D. ottum@comcast.net

SH2-279 (NGC 1977, NGC 1973, NGC 1975)

OTA: RCOS (14.5" f/8) Camera: SBIG STX-16803 Observatory: Deep Sky West
EXPOSURES:

Red:	25 x 900 sec
Blue:	15 x 900
Green:	15 x 900
Lum.:	20 x 900
Hydrogen:	10 x 1800

Total exposure ~24 hours Image Width: ~0.5 deg

Processed by Alex Woronow using PixInsight, Aurora, Affinity Photo (2019)

SH2-279 is an HII emission nebula (red) that also contains reflection nebulae (blue). This object is at the northern-most extent of "Orion's Sword" and the entire sword region, with is extensive array of nebulae, has be cataloged as Orion 1c. The source of ionization of the hydrogen is the young stellar object (YSO) 42 Orionis, which is the the topmost, and brightest of the three stars near the image center. The prominent and famous M42 nebula lies to the upper right of SH2-279, and some of its distal extent is captured in this picture.

The processing involved developing the techniques for applying "Laplacian of Gaussian" sharpening (see Gonzales & Wood, "Digital Image Processing") to an astro-image. The stars pose a substantial problem to such sharpening. The results here are not perfect, but after about 100 hrs of trial-and error, the results show promise.

Ed Note: Compare this image to the one in the March 19 HDO, pg 22

IC 1795 (NGC 896) Fish Head Nebula

OTA: RCOS (14.5" f/8) Camera: SBIG STX-16803 Observatory: Deep Sky West
EXPOSURES:

Hydrogen: 34 x 1800 sec
Sulfur: 27 x 1800
Oxygen: 31 x 1800

Total exposure ~46 hours Image Width: ~1/2 deg

Processed by Alex Woronow using PixInsight & ON1 in 2018

The Narrow-Band Image: Not much has been written about this object. We know it lies at about 6,000 light-years distance, and spans about 70 light-years. Current speculations hold that the gasses of the nebula are excited by very young, hot stars (a few million years old) forming within the nebula, but still out of sight. The are hidden in their natal clouds of gas and dust.

Processing: This image is all in narrow-band emissions: Hydrogen Alpha, Oxygen III and Sulfur II. Images taken in narrow bands such as these usually are mapped to Red/Blue/Green by a variety of schemes. The Pallet is one suggested by Juan Conejero (https://pixinsight.com/forum/index.php?topic=2513.0).

The H-Structure Image: Image processing textbooks frequently mention sharpening by the Laplacian of Gaussian (LoG) method. That was used here on the unstretched Hydrogen image before combining the HSO stacks.

Alex

NGC 7635 “Bubble Nebula”

Object info: The “Bubble nebula”, NGC 7635, is an emission nebula in the constellation Cassiopeia. The bubble is created by stellar wind from a centrally located massive high temperature star which causes it to glow. Distance is approximately 7000 light years

Capture info: HaRGB image, approx. 20hrs. total. 15 minute subs for Ha, 12 minute for RGB. Officina Stellare RiDK 400mm. SBIG 16803, AOX. Paramount MEII. Processing in PixInsight 1.8.6
Location: Orion’s Belt Remote Observatory, Mayhill NM By Dave Doctor

Notes: I almost threw out this whole data set as I failed to appreciate the fact the nebula is buried under a very dense star field. It took quite a while to figure out which star removal algorithm produced the least amount of artifact (notice I say “least”). I have included the RGB image to show what it was that I started out with. The best method I discovered here was sequential star removal, from smaller to bigger stars, using several different star masks in PI and creating several defect maps.