The Eyepiece

SW FL Astronomical Society, Inc.
PO Box 100127
Cape Coral FL 33910

Happy Holidays Everyone!

This month's newsletter is full of great info and pictures. Our member Ray Locke has written and submitted an article on a meridian line project he did in his home in Venice.

We have some great suggestions in our Astronomical League report submitted by John MacLean and a great gift idea suggested in our Night Sky Report.

We have two great speakers this month. Please try to make our general meeting to hear our speaker Dr. Fran Bagenal and her talk on the outer solar system. Click here for more info.

Also, on Dec. 20th Dr. Mario Motta will speak at the Astro SIG meeting. Info on page 10.

And much, much more!

December 2022

- **General Meeting/Elections - Dec. 1st**
- **Speaker Series - Dr, Fran Bagenal, University of Colorado - Exploration of the Outer Solar System: New Horizons at Pluto and Juno at Jupiter**
- **Solar Observing Gilchrist Park - Dec. 3rd**
- **Full Moon - Dec. 7th**
- **Artemis 1 Return To Earth - Dec. 11th**
- **FSW Observing - Dec. 16th**
- **Astro SIG Meeting - Dec. 20th**
- **Dr. Mario Motta speaking at the Astro SIG meeting.**

SWFAS TOC

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Observing Program Dates

Below are the schedules for our Friday public nights at the FSW Observatory (3rd Friday of the month) and the Saturday Solar Observing events (1st Saturday of the month) at county parks.

FSW Observatory

12-16-22
1-20-23
2-17-23
3-17-23
4-21-23
5-19-23

Solar Observing/Park

12-3-22 / Gilchrist
1-7-23 / Ponce de Leon
2-4-23 / Bayshore Live Oak
3-4-23 / Gilchrist
4-1-23 / Ponce de Leon
5-6-23 / Bayshore Live Oak

Monthly Meetings

Our monthly meetings are held on the **first Thursday of each month**. **The meetings begin at 7:00pm**.

This month's meeting will be a combined live and Zoom meeting! Masks are optional.

Each meeting will have the same link/meeting ID (see below).

So, mark your calendar for:

Dec. 1, 2022
Jan. 5, 2023
Feb. 5, 2023

For instructions on how to use Zoom to access our meetings, click here. The actual link is below.

https://widener.zoom.us/j/96535769204

Meeting ID: 965 3576 9204

One tap mobile:
+13126266799,,96535769204#
(or)
+16465588656,,96535769204#

President's Report

The year has gone by quick. Its election time again. We are looking for anyone interested in the officer positions. We especially need someone for Vice President. I have one candidate, but am interested in hearing from anyone else. If you are interested in any of the positions, please let me know so if we have more than one, I can present a brief overview of why you are interested in the position.

It is also coming up on 2023 annual dues time. We normally start collecting these in December. Annual dues are $25.00 per family. This year you can pay your dues online on our website. You can provide us your address and email (in case it has changed) with the renewal. We are using Paypal online so there may be an extra $1 fee if paying that way. Any questions on dues payments please contact John MacLean. If you are having a hardship, please contact an officer and we can make arrangements.

We are changing our mailing address at the start of the year. Mail should be forwarded to us from the Cape PO Box. USPS keeps raising rates and a private mail drop is cheaper and can handle package deliveries as well. We will post the new address in the next newsletter and on the web site when it is active.

We have another Zoom presentation for this month's meeting. Please join the meeting either in person at the planetarium or online. Invite any friends who might be interested to the meeting. Zoom information is in the newsletter. Thanks to John and the program committee for arranging these.

The dates for events at Big Cypress are: 12/17/22, 1/21/2023, 2/18/2023, 3/18/2023

GUEST SPEAKER PRESENTATIONS SERIES

We are excited to announce the initiation of the new "SWFAS Guest Speaker Presentations" series of talks. These will cover astronomical science and space exploration along with practical astronomy and astrophotography talks by various subject matter experts. We are lining up prominent scientists and researchers to explain the science and technology behind the exciting discoveries being made in recent years in astronomy.

The following presentations are already scheduled and we will be firming up talks in 2023 on a month-to-month basis.:

December 1, 2022	Dr, Fran Bagenal, University of Colorado Exploration of the Outer Solar System: New Horizons at Pluto and Juno at Jupiter
January 2023	Craig Stocks - Utah Desert Remote Observatories - "Remote Imaging in the Utah Desert"
February 2, 2023	Dr. Thomas Prettyman, Planetary Science Institute Exploration of the Asteroid Belt

December 1, 2022

Exploration of the Outer Solar System: New Horizons at Pluto and Juno at Jupiter

Dr. Fran Bagenal, Laboratory for Atmospheric and Space Physics University of Colorado, Boulder

OPEN TO ALL SWFAS MEMBERS AND THE PUBLIC - More Info & Zoom Links at https://theeyepiece.org/

The Astronomical League Report

As a member of the Southwest Florida Astronomical Society you are automatically also a member of the Astronomical League, a nationwide affiliation of astronomy clubs. Membership in the AL provides a number of benefits for you including receipt of The Reflector, the AL's quarterly newsletter, use of the Book Service, through which you can buy astronomy related books at a 10% discount. You can also participate in the Astronomical League's Observing Clubs. The Observing Clubs offer encouragement and certificates of accomplishment for demonstrating observing skills with a variety of instruments and objects. These include the Messier Club, Binocular Messier Club, the Herschel 400 Club, the Deep Sky Binocular Club, and many others. To learn more about the Astronomical League and its benefit s for you, visit http://www.astroleague.org

Reflector Magazine

You should have received an email from the Astronomical League linking to your digital copy of the September 2022 Quarterly Reflector magazine on around August 26, You can also directly access copies via the web at https://www.astroleague.org/reflector

Monthly highlight of the Astronomical League Observing Programs
(Article prepared by SWFAS Astronomical League Coordinator John MacLean)

The Astronomical League Open Cluster Observing Program

Last month we covered the Globular Cluster observing program. The League also supports an Open Cluster program with the goal of having the observing complete a challenging observing program while also learning the details of the Trumpler Open Cluster classification system.

There are two levels of awards:

Basic Program

- Observe any 100 of the 125 Open Clusters on the list
- Sketch any 25 of the 100 Open Clusters observed
- Classify all 100 observed clusters under the Trumpler system

Advanced Program

- Observe all 125 of the Open Clusters on the list
- Sketch any 50 of the 125 Open Clusters observed
- Classify all 125 observed clusters under the Trumpler system

For either level, all observing techniques can be used including Go-To, digital setting circles, and star-hopping, etc. To observe all detail possible, The Program Coordinator recommends a minimum aperture of 15 inches! The Program Coordinator successfully completed the advanced program using an 8 inch instrument, however.

The "Open Star Clusters – A Guide for the Open Star Clusters Observing Program" pdf document is included on the website. This document provides the program requirements along with detailed instructions for assigning the correct Trumpler designation and also includes the listing of the 125 objects. The list was compiled from over 20 specialist catalogs along with the well-known Messier and NGC listings. The list of 125 targets includes 9 Messier List objects and 54 which are included in the NGC catalog.

The Night Sky Network

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 nightsky.jpl.nasa.gov to find local clubs, events, and more!

Binoculars: A Great First Telescope

David Prosper

Do you want to peer deeper into the night sky? Are you feeling the urge to buy a telescope? There are so many options for budding astronomers that choosing one can be overwhelming. A first telescope should be easy to use and provide good quality views while being affordable. As it turns out, those requirements make the first telescope of choice for many stargazers something unexpected: a good pair of binoculars!

Binoculars are an excellent first instrument because they are generally easy to use and more versatile than most telescopes. Binoculars can be used for activities like stargazing and birdwatching, and work great in the field at a star party, along the hiking trail, and anywhere else where you can see the sky. Binoculars also travel well, since they easily fit into carry-on luggage – a difficult feat for most telescopes! A good pair of binoculars, ranging in specifications from 7x35 to 10x50, will give you great views of the Moon, large open star clusters like the Pleiades (M45), and, from dark skies, larger bright galaxies like the Andromeda Galaxy (M31) and large nebulae like the Orion Nebula (M42). While you likely won't be able to see Saturn's rings, as you practice your observing skills you may be able to spot Jupiter's moons, along with some globular clusters and fainter nebulae from dark sites, too.

What do the numbers on those binocular specs actually mean? The first number is the magnification, while the second number is the size in millimeters (mm) of the lenses. So, a 7x35 pair of binoculars means that they will magnify 7 times using lenses 35 mm in diameter. It can be tempting to get the biggest binoculars you can find, but try not to get anything much more powerful than a 10x50 pair at first. Larger binoculars with more power often have narrower fields of vision and are heavier; while technically more powerful, they are also more difficult to hold steadily in your hands and "jiggle" quite a bit unless you buy much more expensive binoculars with image stabilization, or mount them to a tripod.

Would it surprise you that amazing views of some astronomical objects can be found not just from giant telescopes, but also from seemingly humble binoculars? Binoculars are able to show a much larger field of view of the sky compared to most telescopes. For example, most telescopes are unable to keep the entirety of the Pleiades or Andromeda Galaxy entirely inside the view of most eyepieces. Binoculars are also a great investment for more advanced observing, as later on they are useful for hunting down objects to then observe in more detail with a telescope.

If you are able to do so, real-world advice and experience is still the best for something you will be spending a lot of time with! Going to an in-person star party hosted by a local club is a great way to get familiar with telescopes and binoculars of all kinds – just ask permission before taking a closer look! You can find clubs and star parties near you on the Night Sky Network's Clubs & Events page at bit.ly/nsnclubsandevents, and inspire your binocular stargazing sessions with NASA's latest discoveries at nasa.gov.

The two most popular types of binocular designs are shown here: roof-prism binoculars (left) and porro-prism binoculars (right). Roof prisms tend to be more compact, lighter, and a bit more portable, while porro-prisms tend to be heavier but often offer wider views and greater magnification. What should you choose? Many birders and frequent fliers often choose roof-prism models for their portability. Many observers who prefer to observe fainter deep-sky objects or who use a tripod with their observing choose larger porro-prism designs. There is no right answer, so if you can, try out both designs and see which works better for you.

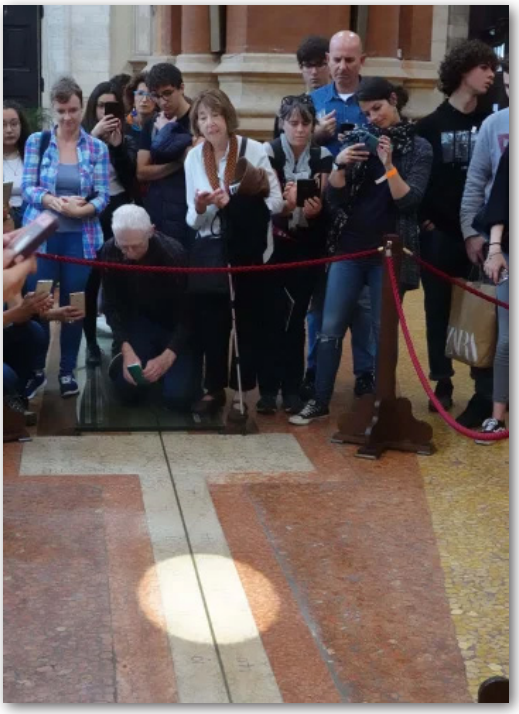
A pair of good binoculars can show craters on the Moon around 6 miles (10 km) across and larger. How large is that? It would take you about two hours to hike across a similar-sized crater on Earth. The "Can You See the Flag On the Moon?" handout showcases the levels of detail that different instruments can typically observe on the Moon, available at bit.ly/flagmoon. Lunar eclipse composite image by Mike Jensen

A Meridian Line in Venice Florida

A Meridian Line in Venice Florida

A Member submitted article by Ray Locke

Having sailed to the Caribbean several times, I had occasion to use celestial navigation (either using a noon sun fix or an evening star sight) and closer to home…… to watch the progress of the sun through the different windows of our house in Venice…and finally having read an article in Sky and Telescope about Cassini constructing a meridian line in the Italy Bologna's Basilica di San Petronio …….. and SO with time on my hands, I decided to make my own Meridian Line in front of our house over our covered driveway! Wife made no objections!



The first challenge was to use Trig to calculate the height of the hole in the underside of the roof (147″) and the maximum angle of the sun in the winter (39.48°) so that I could get the total length of the line. (166.6″). Then I had to locate the hole in the roof so that the line could fit on the driveway floor avoiding the patio furniture or the parked car. Cassini's line was 219′ and just fit between two columns of the basilica.

My line was only 166″ but had to be a true N-S line. This was a bit tricky as I started by using a cell phone compass and had to account for a 4″ W Variation and some Deviation caused by the rebar in the driveway. This was a start but to get a really true N-S line, I had to refine this after I cut the hole in the ceiling by using 'shadow progression method' a few hours either side of solar noon. This got me an E-W line and then I used a right angle square to get N-S. I suppose I could have used my Celestron 9.25 Telescope somehow but didn't.

So, I finally had the total length and orientation of the Meridian line, and now I could locate it on the floor, but still had to determine where the hole in the roof would be. I used a vertical laser to spot the line, and a laser dot to locate where the hole in the roof would be. See Photo. I could have used a plumb bob instead but didn't want to spend time on a ladder. I went on the roof and cut an oversized hole in the thick aluminum clad roof and removed all the insulation. The hole had to be oversized to account for the angle of the sun when it got to the sun hole in the underside of the roof. I used a piece of thick glass to cover the hole and caulked it thoroughly. Then I cut a 1 ½″ hole in the bottom of the ceiling to create the actual sun spot. I camouflaged this with a Sunflower Décor that I cut the center out. Cassini did something similar!

I then purchased two pieces of 1/8″ x 1.5″ x 8′″ of brass and proceeded to etch them using resist paper, 12vdc and etching solutions. I had varied luck with this. I farmed out the laser cut letters to Etsy but had a hard time getting right resist paper for the fine details. Some etchings turned out good but most have stood the test of time poorly. If I had more courage, I would cut a thin slot in the driveway pavement and insert special tiles, or use stainless, or? Still am not satisfied. Part of it is that we park the car over the Line.

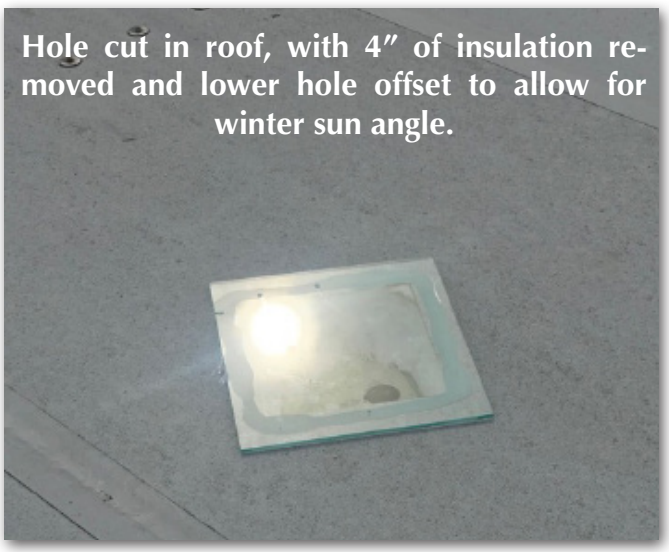
For my calculations I used the very helpful website Suncalc.org. This easily tells me the time of solar noon for my longitude and the angle of the sun at my latitude. For further fun, I used the program Skyflow to get the time lapse of the sun traversing the Meridian Line.

I also inscribed the words "Tempus Fugit" on the brass, or I could have used "Sol Fugit"!

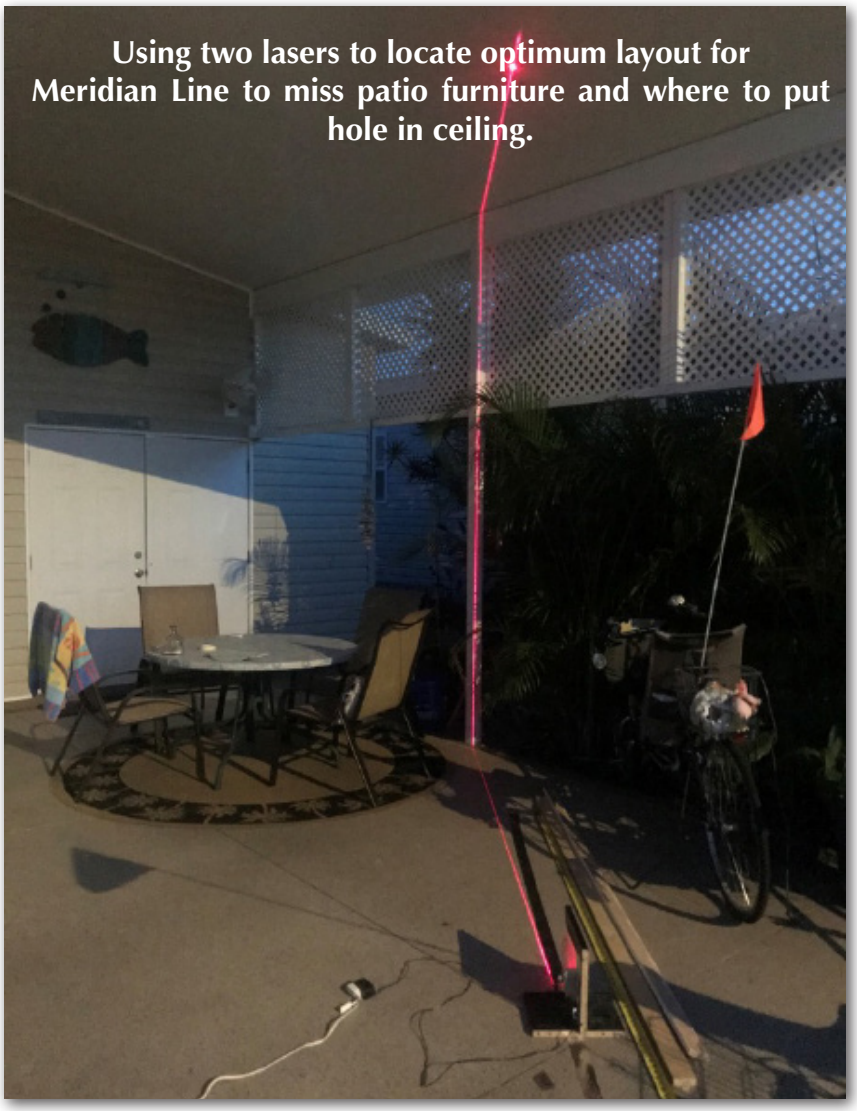
Sunspot at Solar Noon crossing brass strip after summer Equinox.

Acid etching brass strip with local lat/long using resist and duct tape.

Sunflower motif to hide the hole in the lanai ceiling and allow sun to pass.



Hole cut in roof, with 4" of insulation removed and lower hole offset to allow for winter sun angle.



Using two lasers to locate optimum layout for Meridian Line to miss patio furniture and where to put hole in ceiling.

Astrophotography (SIG)
Special Interest Group

Join Our Astrophotography Special Interest Group (SIG)
– Mike Jensen, Group Lead

REGULAR MEETINGS
Regular meetings are usually on the Third Tuesday of each month,
The next meeting is Tuesday Dec. 20th at 6:30

https://us02web.zoom.us/j/81077794455?pwd=MHJVL2VvZGZRK3JyM-1d5QVJiZE1TUT09

Meeting ID: 810 7779 4455
Passcode: Phot@S!G

ABOUT THE ASTRO SIG

Every month we get together on a Zoom call with a pretty loose agenda and manage to have an absolute blast talking about Astrophotography. I hope you'll join us if you're interested in Astrophotography.

We have a nice, diverse group with a wide range of skill sets and interests. Some DSLR/Mirrorless shooters mixed in with telescope shooters. Some use Star Trackers, some use goto mounts, some use laptops and some use a fun little unit called the ASIAIR (a small little computer inside a box about the size of a cell phone that connects to a tablet or smart phone).

On any given day or moment we can shoot an email out to the group and get suggestions and answers, how cool is that?

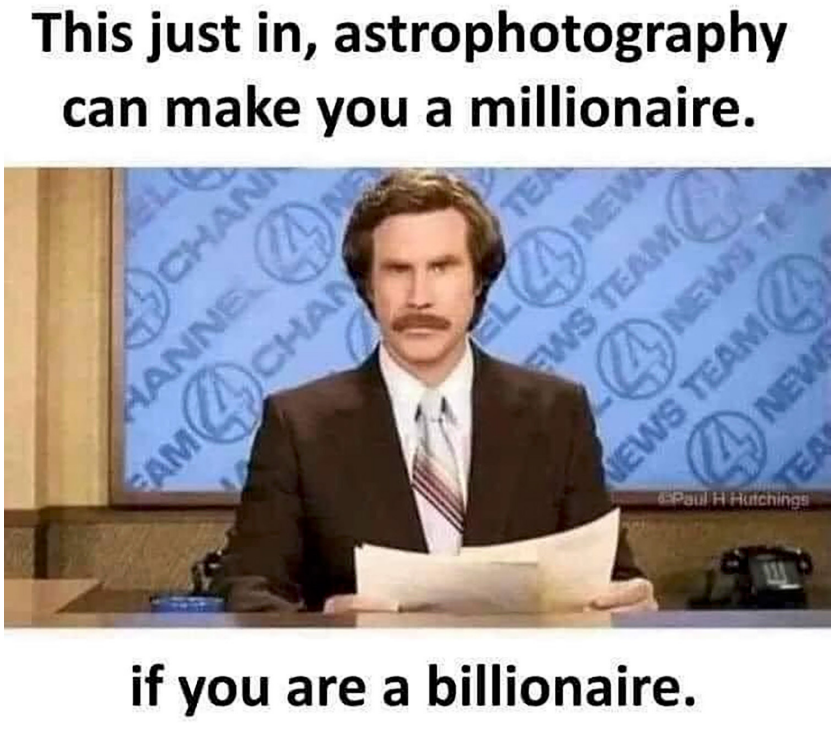
Now, the REALLY cool thing is that it looks like the pandemic is FINALLY starting to ease off so that means we can finally start getting together and be safe! That means more helping each other, more show and tell, more mentorship which is exactly why we created the Astro SIG.

So, if you want to learn Astrophotography (like Astro 101) with a LOT of fun people, join us.

IMAGING TRIPS TO BIG CYPRESS

Big Cypress National Park is about a 75 minute drive from Ft. Myers and it is probably one of the darkest areas in the state of Florida. We have a great place to set up and frequently meet astrophotographers and observers from other parts of the state.

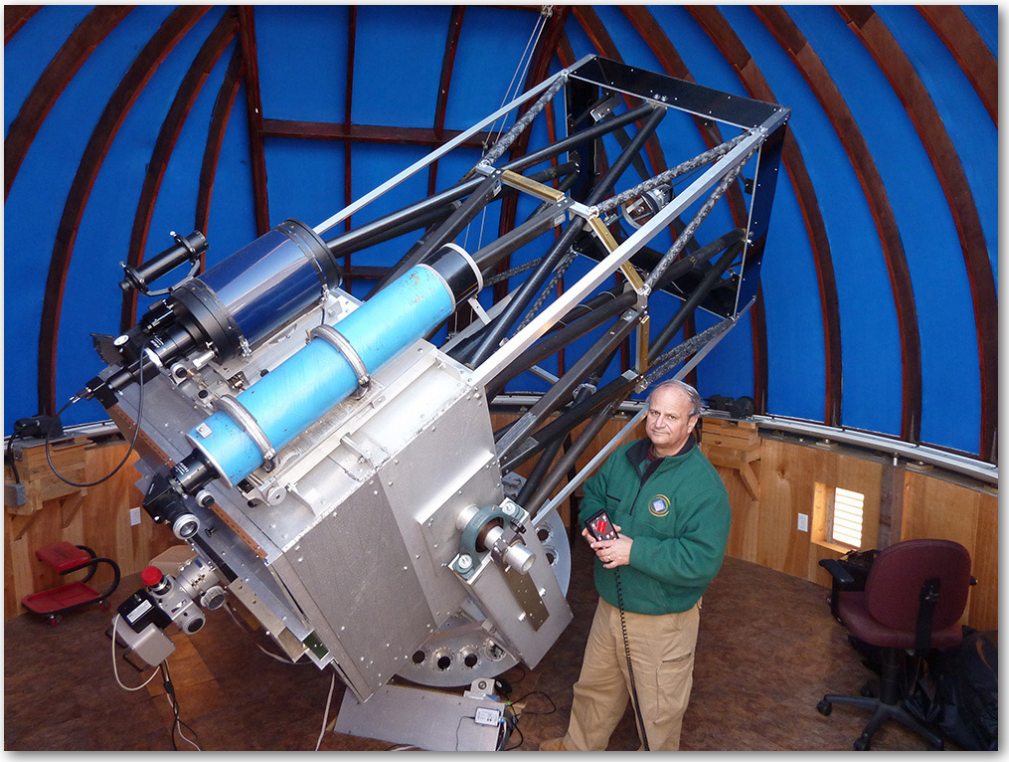
The best way to stay tuned in to our impromptu field trips is to get on our Astro SIG Google Groups email list. Contact Mike Jensen.



Astro SIG Speaker Dec. 20th

Dr. Mario Motta to speak on building his own 32″ telescope and observatory to house it.

Mario is well known as an astronomer. Working with the American Association of Variable Star Observers, Harvard–Smithsonian Center for Astrophysics, and MIT, he has numerous observations and publications.



In 2013, the International Astronomical Union named an asteroid in his honor. (Asteroid 133537mariomotta) In the astronomical community, Dr. Motta is well known for his large and completely homemade telescope and observatory including the optics, a 32-inch f6 telescope.

Mario Motta has been on the Board of Trustees of the AMA from 2018 to 2022. He has been active in organized medicine and the AMA since medical school at Tufts University in Boston. As chair of the MMS Committee on Legislation, he was intimately involved with Massachusetts health care reform, resulting in the state having the lowest rate of uninsured residents in the United States.

About Mario Motta

From Mario's website.

As a teenager, I started grinding mirrors and building telescopes because my dreams always exceeded my budget. My projects include a 16-inch Newtonian reflector and backyard observatory finished in the 1980s, and a 32-inch Newtonian and another observatory built in the '90s. When my wife, Joyce, and I planned a move to Gloucester, Massachusetts (her for the natural beauty of the beach, and I for the darker sky), we agreed that an observatory would be an integral part of our new house.

Given today's plethora of commercial telescopes, some people wonder why I still build my own. The answers are simple: for large telescopes, it can be very cost effective, you control the quality, and there's real pride in making and using your own instrument.

Astro SIG Zoom Meeting
Dec. 20th 6:30pm

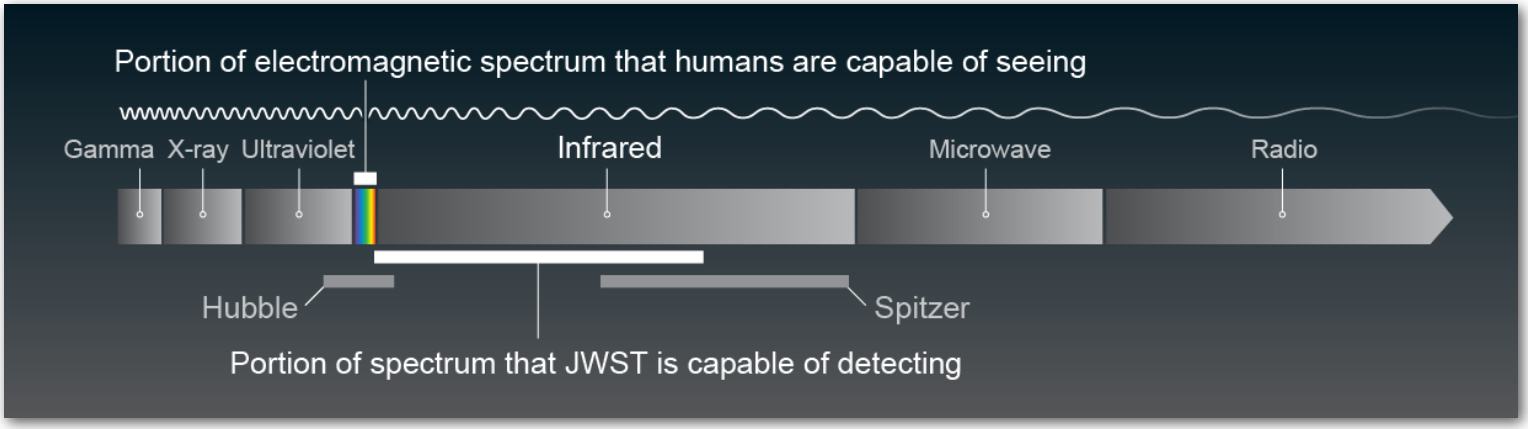
https://us02web.zoom.us/j/81077794455?pwd=MHJVL2V-vZGZRK3JyM1d5QVJiZE1TUT09

Meeting ID: 810 7779 4455

Passcode: Phot@S!G

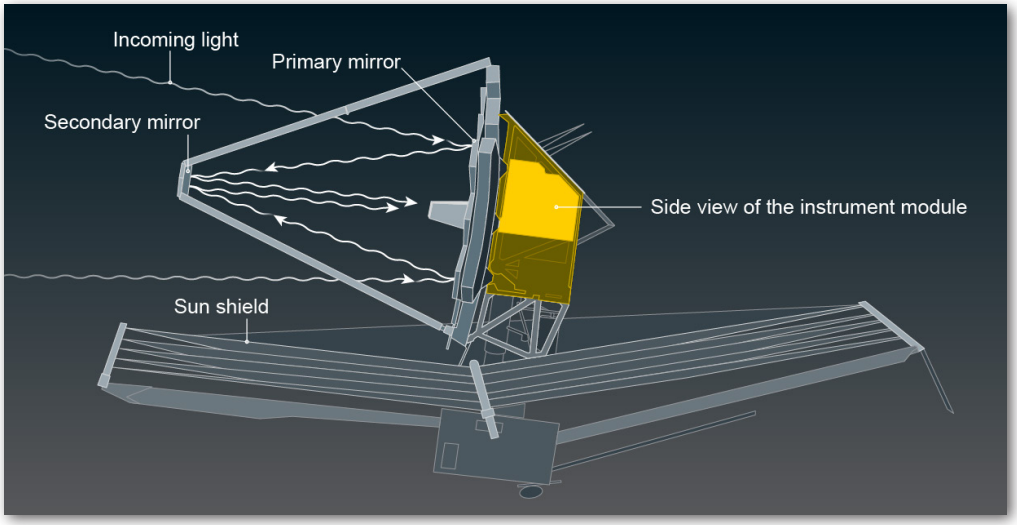
Are the JWST Pictures 'Real'?

From Scientific American
Source article: https://www.scientificamerican.com/article/are-the-james-webb-space-telescopes-pictures-real/



As light travels through space, it gets stretched by the expansion of the universe. This is why many of the most distant objects shine in infrared light, which is longer in wavelength than visible light. We can't see this ancient light with our eyes, but the James Webb Space Telescope (JWST) was designed to capture it, revealing some of the first galaxies ever to form.

JWST's core includes four science instruments, described below, that collect its data.



SIX DATA COLLECTION COMPONENTS . . .
Aperture Masking: A perforated metal plate blocks some of the light entering the telescope, allowing it to simulate an interferometer, which combines data from multiple telescopes to achieve higher resolution than a single lens. The technique reveals more details of very bright objects close together, such as two stars nearby on the sky.

Micro Shutter Array: A grid of 248,000 small doors can open or close to measure spectra—light spread into its constituent wavelengths—from up to 100 points in a single frame.
Spectrographs: Gratings or prisms separate incoming light into spectra to reveal the intensity of individual wavelengths.

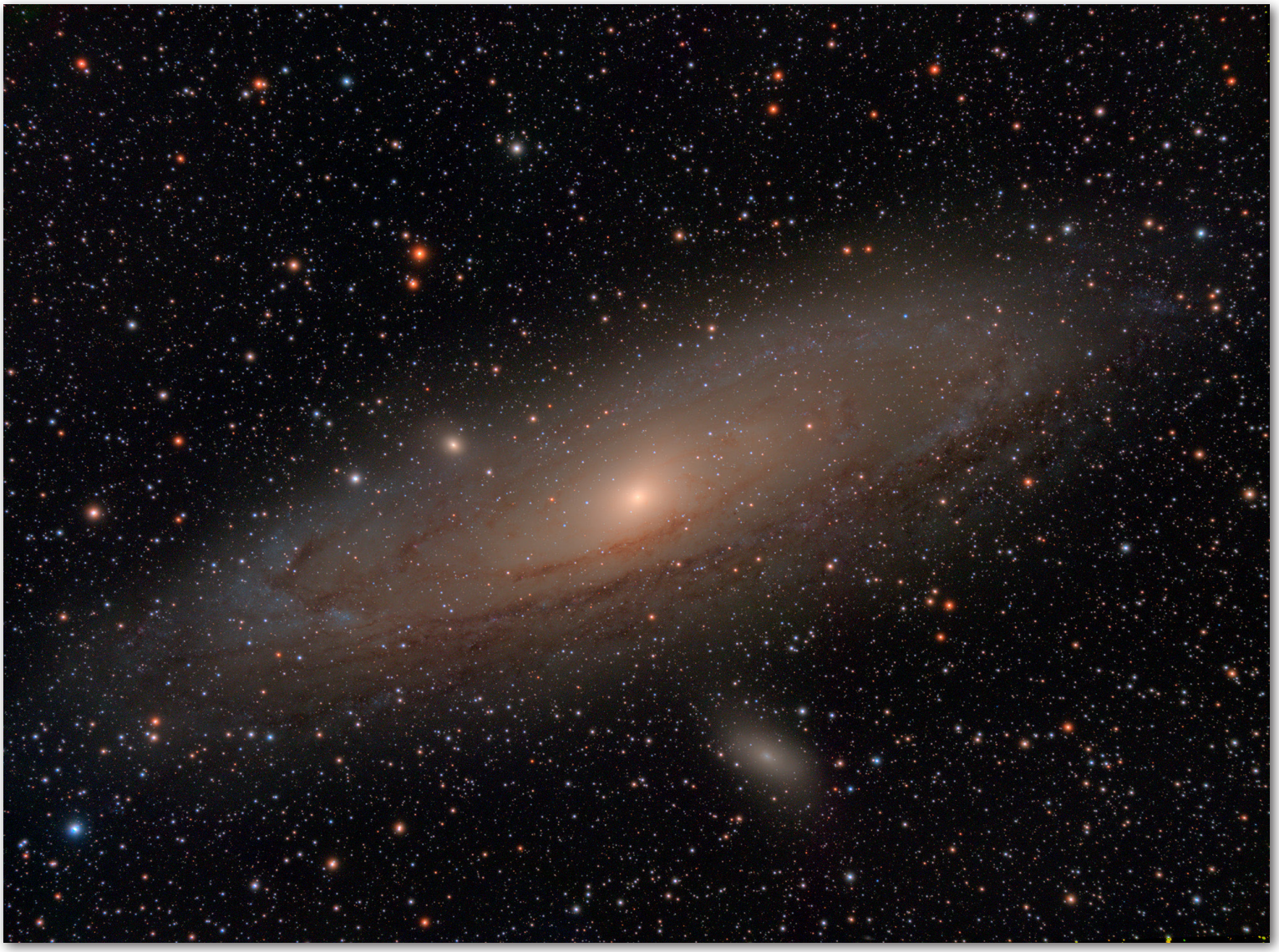
Cameras: JWST has three cameras—two that capture light in the near-infrared wavelength range and one that works in the mid-infrared.

Integral Field Unit: A combined camera and spectrograph captures an image, along with spectra for each pixel, revealing how the light varies across the field of view.

Coronagraphs: Glare from bright stars can blot out fainter light from planets and debris disks orbiting those stars. Coronagraphs are opaque circles that block that bright starlight to let the weaker signals through.

Click here to continue reading this article...

Astro SIG Images



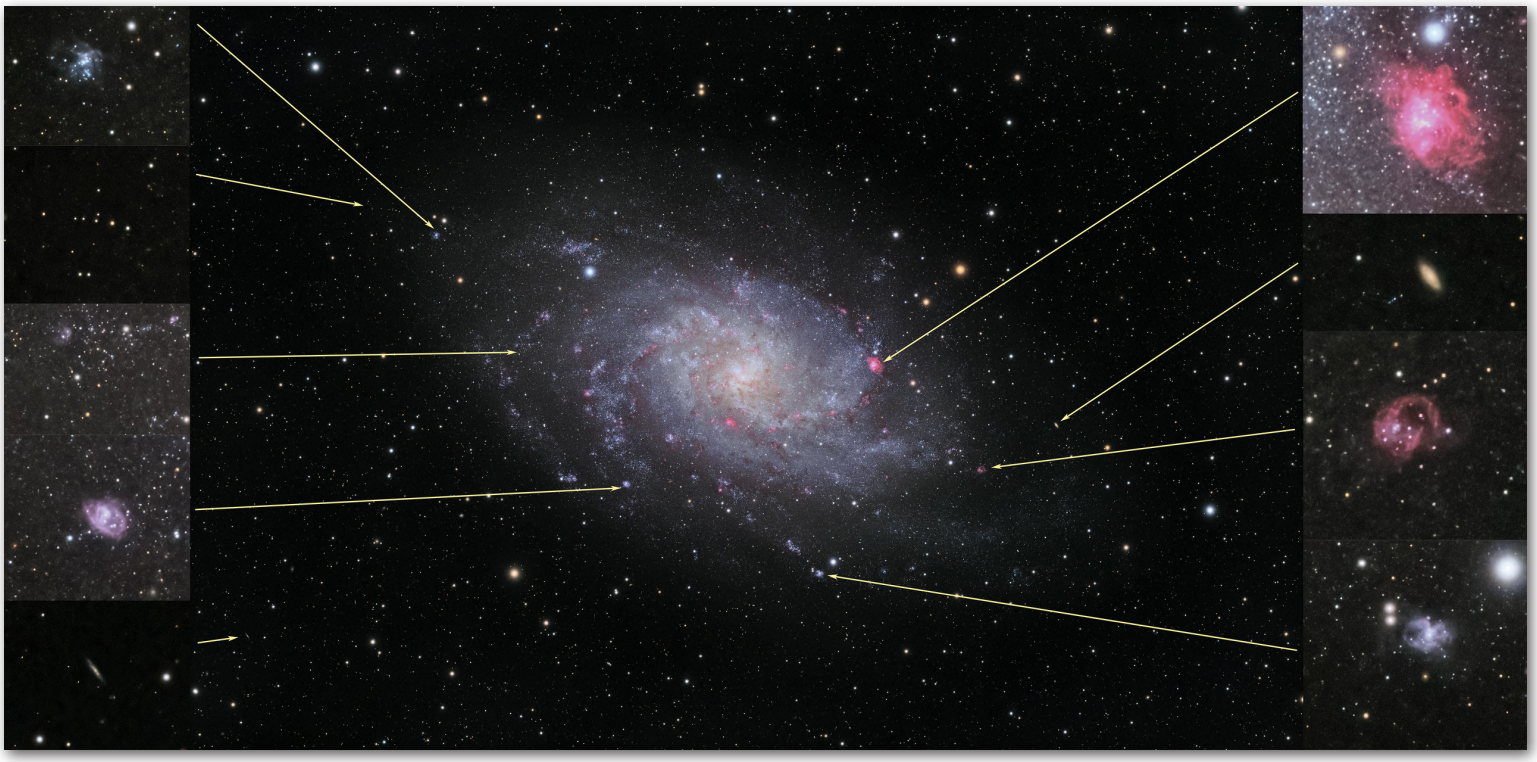
M-31, The Andromeda Galaxy By **Mike Jensen**

After practicing my image data collection for a year I wanted to get a nice image of M-31 this Fall and I'm really happy with this one! This image took four nights to record. It was done in late October in my back yard in Port Charlotte.

I processed it in PixInsight, a new software for me. I spent about two weeks learning the software, reading and viewing videos from an Adam Block tutorial. What finally got me over the finish line was an assist from my friend and fellow astrophotographer Linwood Ferguson!

Image Data

Luminance -	190 x 120sec
Red -	150 x 240sec
Green -	150 x 240sec
Blue -	150 x 240sec
Ha -	87 x 240sec
Total -	42 hours
Darks, Bias, Flats	



M33 Triangulum (SVX152T First Light) by **Linwood Ferguson**

This is my first image with my new Stellarvue SVX152T. I left it in too high of resolution so you can explore the details to judge how well the optics worked, and it is an uncropped full frame to see the stars in the corners. I think it did pretty well.

This was shot from my Bortle 7 back yard, and I kept adding data hoping to bring out some of the halo detail. It has about 39 hours, 4 of which is HA, and about 11 hours each of Red, Green and Blue.

This was taken in five consecutive nights ending 10/27/2022, in a surprisingly clear stretch of days.

M33 is part of our local group, a bit further away than Andomeda and likely gravitationally linked to it, and moving toward us. It is currently about 3.5 million light years away, and while smaller than the milky way has exceptionally active star forming regions, here highlighted in red from the Hydrogen Alpha exposures. This is the further object visible by the naked eye (but only with dark, excellent conditions).

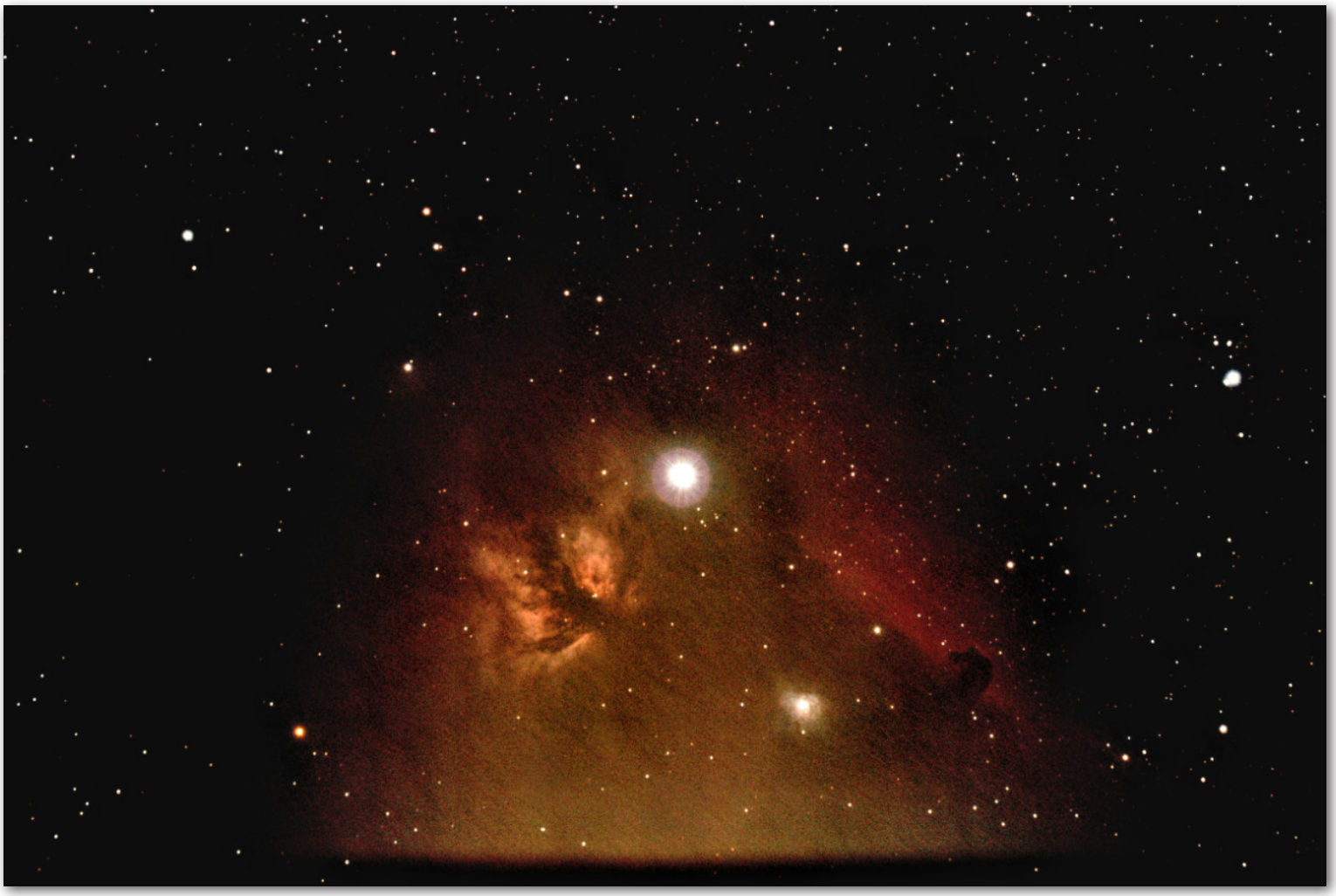
Image Data

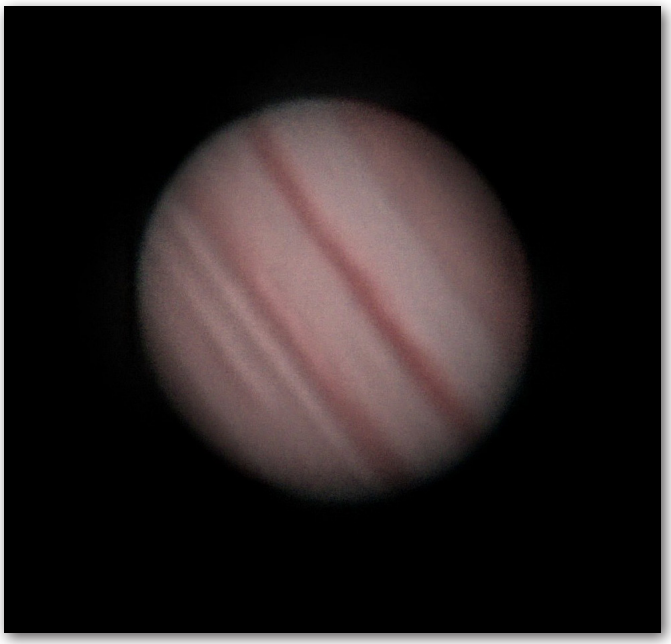
Chroma Blue 2″: 178×240 (11h 52) (gain: 100.00) f/8 -5°C bin 1×1

Chroma Green 2″: 175×240 (11h 40) (gain: 100.00) f/8 -5°C bin 1×1

Chroma H-alpha 5nm Bandpass 50 mm: 51×300(4h 15) (gain: 100.00) f/8 -5°C bin 1×1

Chroma Red 2″: 173×240(11h 32) (gain: 100.00) f/8 -5°C bin 1×1





Images By Steve Sandor

Here are some images submitted by member Steve Sandor. Above the Flame Nebula. The Flame Nebula, designated as NGC 2024 and Sh2-277, is an emission nebula in the constellation Orion. It is about 900 to 1,500 light-years away.

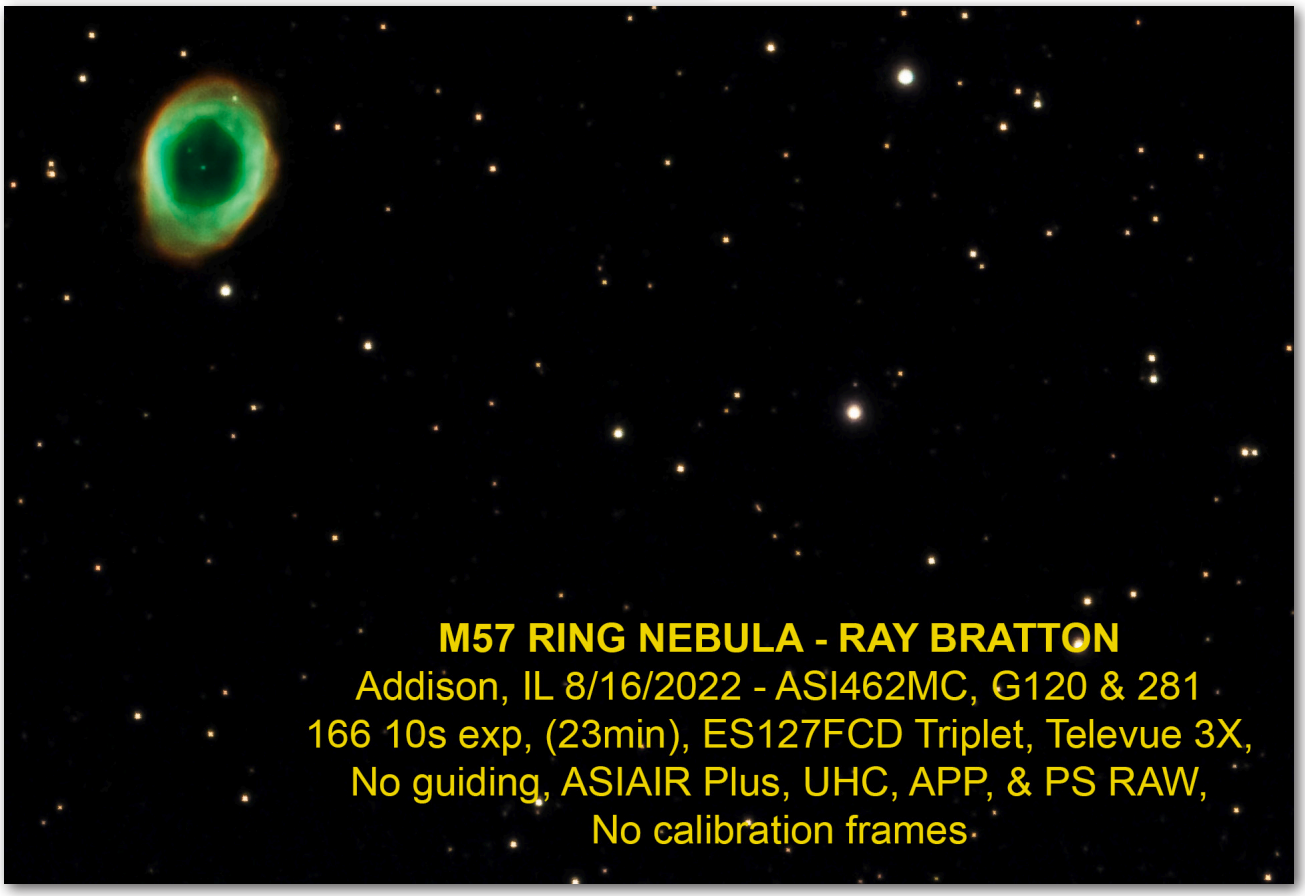
Left, Jupiter. Jupiter is the fifth planet from the Sun and the largest in the Solar System. It is a gas giant with a mass more than two and a half times that of all the other planets in the Solar System combined, but slightly less than one-thousandth the mass of the Sun.

Next page top is The Pleiades. The Pleiades, also known as The Seven Sisters, Messier 45 and other names by different cultures, is an asterism and an open star cluster containing middle-aged, hot B-type stars in the north-west of the constellation Taurus. At a distance of about 444 light years, it is among the nearest star clusters to Earth.

Next page bottom is the Pacman Nebula. NGC 281, IC 11 or Sh2-184 is a bright emission nebula and part of an H II region in the northern constellation of Cassiopeia and is part of the Milky Way's Perseus Spiral Arm.

Saturn - near Opposition 8/9/2022
Addison, Illinois - Ray Bratton
ES127 FCD Triplet, 3X Televue, UHC,
ASI462MC, ASIAIR Plus, Video Capture,
250G, 8ms, 15148 frames, PIPP 2500 frames,
ASk! 50%, Reg6 wavelets, PS RAW

Images by Ray Bratton



M57 RING NEBULA - RAY BRATTON
Addison, IL 8/16/2022 - ASI462MC, G120 & 281
166 10s exp, (23min), ES127FCD Triplet, Televue 3X,
No guiding, ASIAIR Plus, UHC, APP, & PS RAW,
No calibration frames

M 33 - The Triangulum Galaxy by **Don Bishop**. This is a spiral galaxy 2.73 million light-years from Earth in the constellation Triangulum. It is cataloged as Messier 33 or NGC 598.

This is actually a "composite" image, a first for me. I first shot this with my ASI294MC-Pro color camera on a Televue 85 with a 0.8x reducer/flattener. It was mounted on a CEM40 and controlled with an ASIAir Pro shot here in Babcock Ranch. I shot 82 five minute sub exposures for almost 7 hours total. That image is depicted on the right.

Several weeks later I was testing my ASI294MM-Pro camera after taking it apart looking for an intermittent connection problem. I ended up shooting a little over 4 hours of Ha at 5 minutes subs with it using the same set up as above. I also managed to get about 1 hour of Luminance with 5 minute subs.

My challenge was how to combine all the data. I discovered that I had to reprocess the RGB data and separate it into individual R, G and B channels. I then calibrated the data and saved the results. I then processed the mono data, calibrated the Ha and L channels and saved them. All of this was done in APP and I then loaded all of the separate channels into APP and processed it as mono data. After combining the channels and stretching, I did a final touch up in Lightroom, nothing fancy.

The Artemis launch from Babcock Ranch taken by Don Bishop

Good Night Oppy

A Feel Good Documentary

Charting the remarkable true story of Opportunity, a NASA exploration rover that was sent to Mars for a 90-day mission but ended up surviving for 15 years.

The film follows Opportunity, the Mars Exploration Rover affectionately dubbed Oppy by her creators and scientists at NASA. Oppy was originally expected to live for only 90 days but she ultimately explored Mars for nearly 15 years.

In 2019, Film 45 partnered with Steven Spielberg's company Amblin Television to tell the story of Opportunity. In March 2020, Brandon Carroll of Film 45 met with Ryan White and producer Jessica Hargrave to discuss the project. In November 2020, the filmmakers approached potential distributors with a 17-minute sizzle reel. In March 2021, it was announced that Amazon Studios, Film 45, Amblin Television and Tripod Media would be co-producing Good Night Oppy, a feature about the Mars exploration rover Opportunity. It was acquired by Amazon Studios in November 2021, and completed the following month.

The film is narrated by Angela Bassett, with visual effects work from Industrial Light & Magic, and archival footage provided by NASA and the Jet Propulsion Laboratory. It was written by director Ryan White and editor Helen Kearns.

Well Received

Ben Kenigsberg of The New York Times wrote, "While descriptions of the aging robots as experiencing arthritis and memory loss are perhaps too cute, by the end of 'Good Night Oppy,' Opportunity and Spirit have become no less lovable as characters than R2-D2 or Wall-E." Michael O'Sullivan of The Washington Post awarded it 2.5 out of 4 stars, writing, "It's such a feel-good little story that Oppy might instill in you the same warm and fuzzy feeling of gratification that she obviously has in her NASA family."

Aurora Amidon of Paste wrote that the film is "sentimental but rarely over the top, dazzling to look at, frequently dabbles in the realm of the nail-biting thriller and, on top of all that, it's highly informative." Matt Zoller Seitz of RogerEbert.com awarded it 3 out of 4 stars, writing, "To get across the magnitude of what his subjects saw and did, White pours on the commercial filmmaking devices from start to finish, in the manner of fun-for-all-ages summer blockbusters that used to dominate the box office in the 1980s and '90s," adding that "the score by Blake Neely has that John Williams magic-and-wonder vibe."

Terrestrial Coordinates

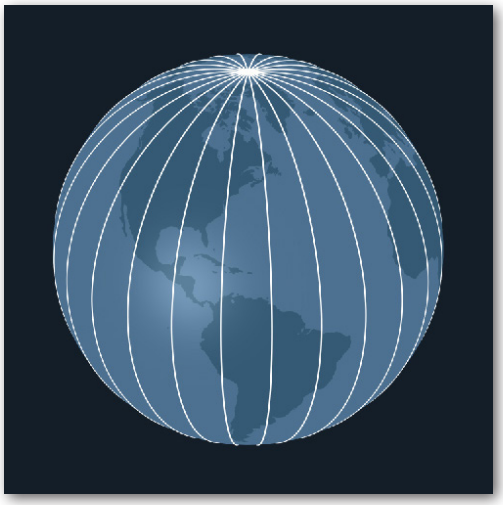
Source: https://solarsystem.nasa.gov/basics/chapter2-1

Spatial coordinates and timing conventions are adopted in order to consistently identify locations and motions of an observer, of natural objects in the solar system, and of spacecraft traversing interplanetary space or orbiting planets or other bodies. Without these conventions it would be impossible to navigate the solar system.

Terrestrial Coordinates

A great circle is an imaginary circle on the surface of a sphere whose center is the center of the sphere. Great circles that pass through both the north and south poles are called meridians, or lines of longitude. For any point on the surface of Earth a meridian can be defined.

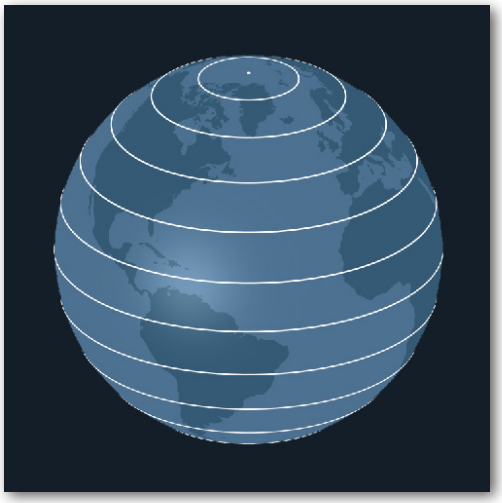
The prime meridian, the starting point measuring the east-west locations of other meridians, marks the site of the old Royal Observatory in Greenwich, England. Longitude is expressed in degrees, minutes, and seconds of arc from 0 to 180 degrees eastward or westward from the prime meridian. For example, downtown Pasadena, California, is located at 118 degrees, 8 minutes, 41 seconds of arc west of the prime meridian: 118° 8′ 41″ W.



Lines of Longitude

Lines of latitude.
The starting point for measuring north-south locations on Earth is the equator, a great circle which is everywhere equidistant from the poles. Circles in planes parallel to the equator define north-south measurements called parallels, or lines of latitude. Latitude is expressed as an arc subtended between the equator and the parallel, as seen from the center of the Earth. Downtown Pasadena is located at 34 degrees, 08 minutes, 44 seconds latitude north of the equator: 34° 08′ 44″ N.

One degree of latitude equals approximately 111 km on the Earth's surface, and by definition exactly 60 nautical miles. Because meridians converge at the poles, the length of a degree of longitude varies from 111 km at the equator to 0 at the poles where longitude becomes a point.

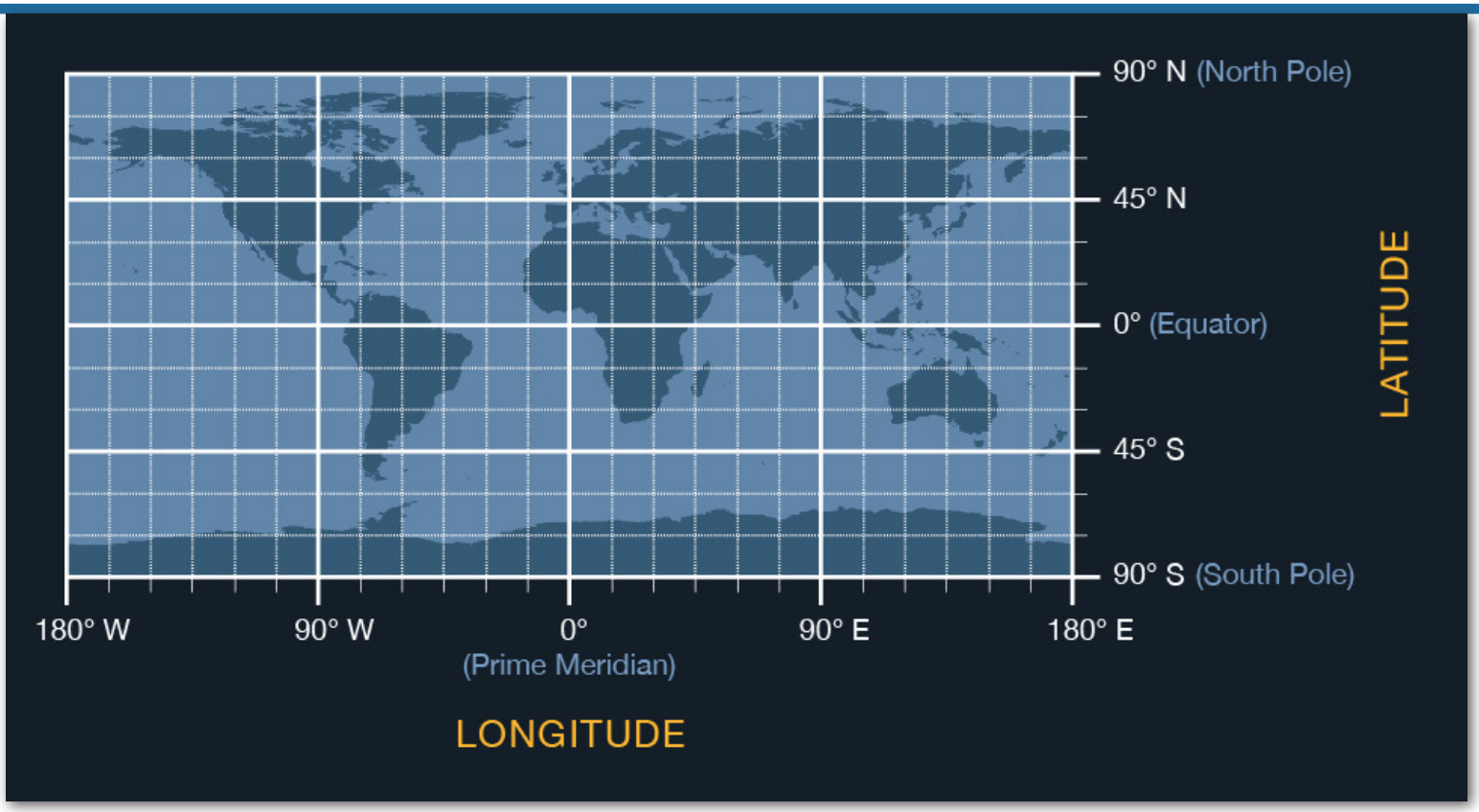


Lines of Latitude

Rotation and Revolution
"Rotation" refers to an object's spinning motion about its own axis. "Revolution" refers the object's orbital motion around another object. For example, Earth rotates on its own axis, producing the 24-hour day. Earth revolves about the Sun, producing the 365-day year. A satellite revolves around a planet.

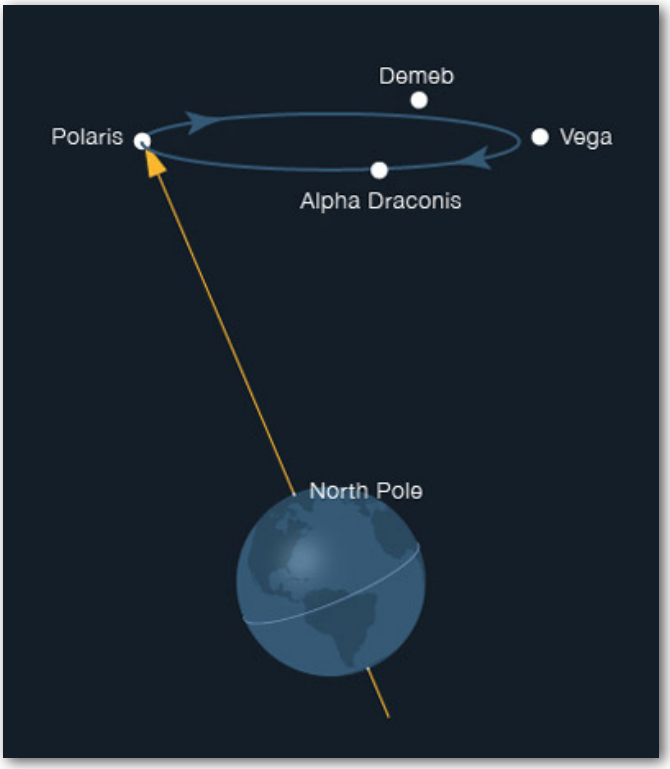
Earth's Rotation
The Earth rotates on its axis relative to the sun every 24.0 hours mean solar time, with an inclination of 23.45 degrees from the plane of its orbit around the sun. Mean solar time represents an average of the variations caused by Earth's non-circular orbit. Its rotation relative to "fixed" stars (sidereal time) is 3 minutes 56.55 seconds shorter than the mean solar day, the equivalent of one solar day per year.

Forces associated with the rotation of Earth cause the planet to be slightly oblate, displaying a bulge at the equator. The moon's gravity primarily, and to a lesser degree the sun's gravity, act on Earth's oblateness to move



Terrestrial Coordinates Grid

the axis perpendicular to the plane of Earth's orbit. However, due to gyroscopic action, Earth's poles do not "right themselves" to a position perpendicular to the orbital plane. Instead, they precess at 90 degrees to the force applied. This precession causes the axis of Earth to describe a circle having a 23.4 degree radius relative to a fixed point in space over about 26,000 years, a slow wobble reminiscent of the axis of a spinning top swinging around before it falls over.



Precession of Earth's axis over 26,000 years.

Because of the precession of the poles over 26,000 years, all the stars, and other celestial objects, appear to shift west to east at the rate of .014 degree each year (360 degrees in 26,000 years). This apparent motion is the main reason for astronomers as well as spacecraft operators to refer to a common epoch such as J2000.0.

At the present time in Earth's 26,000 year precession cycle, a bright star happens to be very close, less than a degree, from the north celestial pole. This star is called Polaris, or the North Star.

Stars do have their own real motion, called proper motion. In our vicinity of the galaxy, only a few bright stars exhibit a large enough proper motion to measure over the course of a human lifetime, so their motion does not generally enter into spacecraft navigation. Because of their immense distance, stars can be treated as though they are references fixed in space. (Some stars at the center of our galaxy, though, display tremendous proper motion speeds as

they orbit close to the massive black hole located there.)

Nutation

Superimposed on the 26,000-year precession is a small nodding motion with a period of 18.6 years and an amplitude of 9.2 arc seconds. This nutation can trace its cause to the 5 degree difference between the plane of the Moon's orbit, the plane of the Earth's orbit, and the gravitational tug on one other.

Revolution of Earth

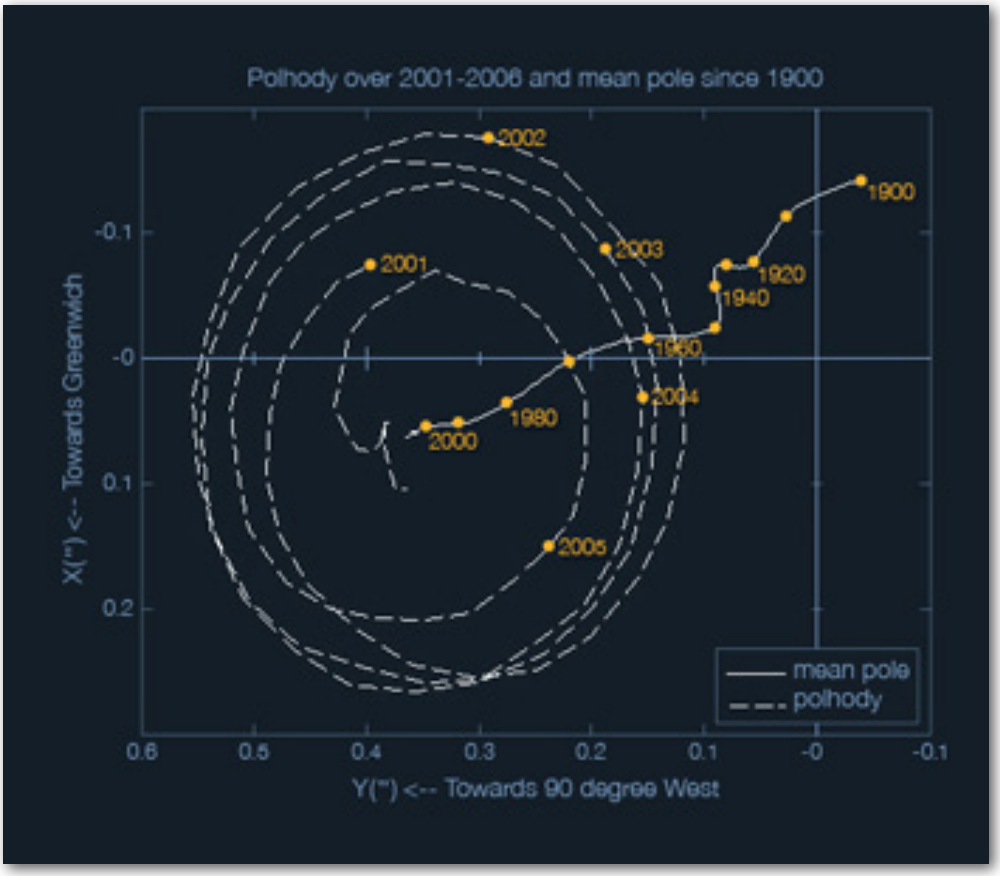
Earth revolves in orbit around the sun in 365 days, 6 hours, 9 minutes with reference to the stars, at a speed ranging from 29.29 to 30.29 km/s. The 6 hours, 9 minutes adds up to about an extra day every fourth year, which is designated a leap year, with the extra day added as February 29th. Earth's orbit is elliptical and reaches its closest approach to the sun, a perihelion of 147,090,000 km, on about January fourth of each year. Aphelion comes six months later at 152,100,000 km.

Shorter-term Polar Motion

Aside from the long-term motions, the Earth's rotational axis and poles have two shorter periodic motions. One, called the Chandler wobble, is a free nutation with a period of about 435 days. There is also a yearly circular motion, and a steady drift toward the west caused by fluid motions in the Earth's mantle and on the surface. These motions are tracked by the International Earth Rotation and Reference Systems Service, IERS.

Epochs

Movement of Earth's rotational poles Movement of Earth's rotational poles 2001 to 2006, and the mean pole location from the year 1900 to 2000. Because we make observations from Earth, knowledge of Earth's natural motions is essential. As described above, our planet rotates on its axis daily and revolves around the sun annually. Its axis precesses and nutates. Even the "fixed" stars move about on their own. Considering all these motions, a useful coordinate system for locating stars, planets, and spacecraft must be pinned to a single snapshot in time. This snapshot is called an epoch.

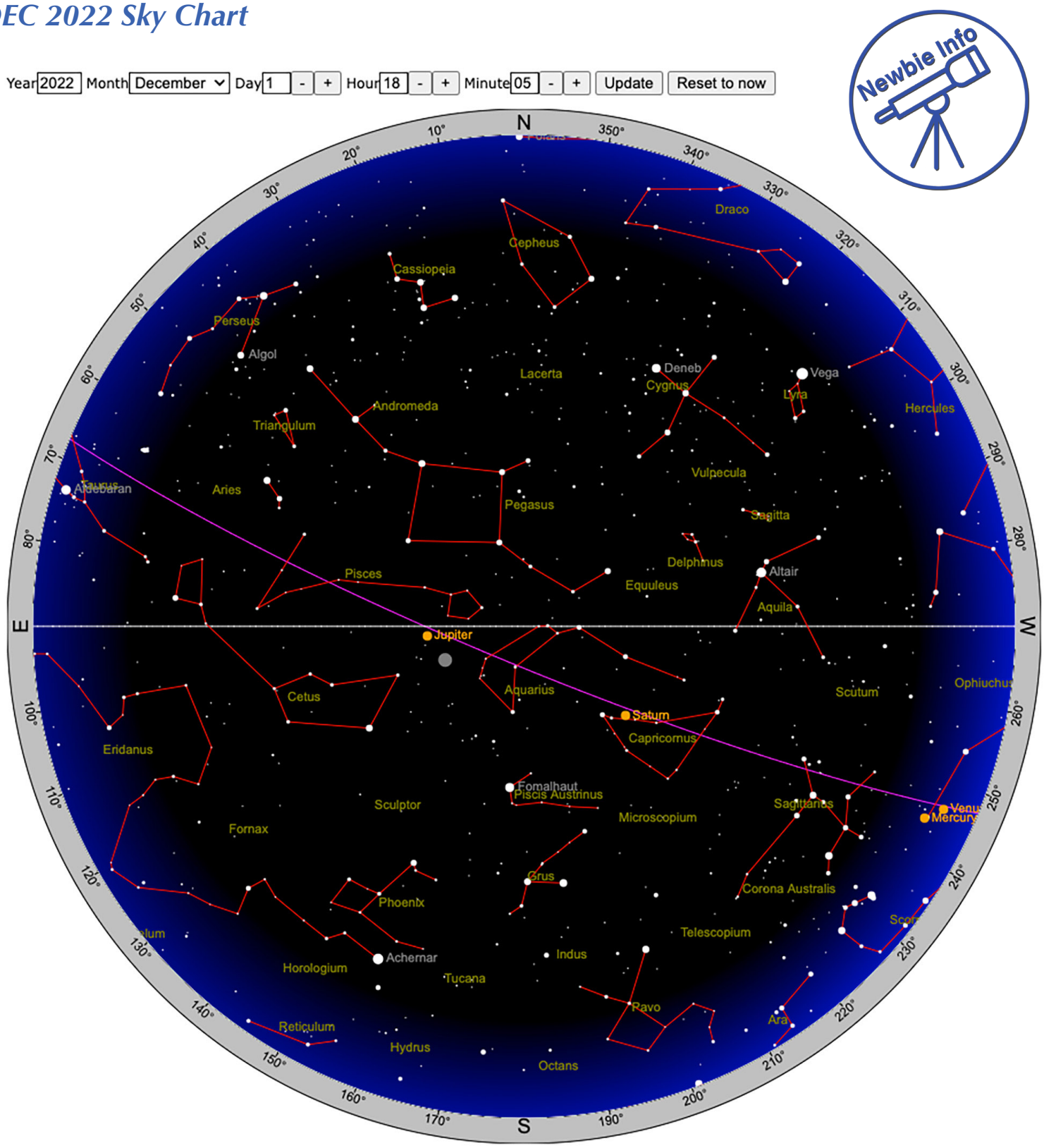


Movement of Earth's rotational poles 2001 to 2006, and the mean pole location from the year 1900 to 2000.

By convention, the standard reference epoch is J2000.0, which refers to the mean equator and equinox of year 2000, nominally January 1st 12:00 hours Universal Time (UT). The "J" means Julian year, which is 365.25 days long. Only the 26,000-year precession part of the whole precession/nutation effect is considered, defining the mean equator and equinox for the epoch.

The last epoch in use previously was B1950.0 - the mean equator and equinox of 1949, Dec. 31 22:09 UT, the "B" meaning Besselian year, the fictitious solar year introduced by F. W. Bessell in the 19th century. Equations are published for interpreting data based on past and present epochs.

DEC 2022 Sky Chart



You can download or view this map better at: https://heavens-above.com/skychart2.aspx?lat=0&lng=0&loc=Unspecified&alt=0&tz=UCT

Planet Positions

Click on the graphic above to go to Time and Date for a great simulation of the rotation of the constellations and the rising/setting of the planets. The chart below is set for the date of our meeting but can be programmed for any date and time. The chart can also be found at this link on Heavens Above.

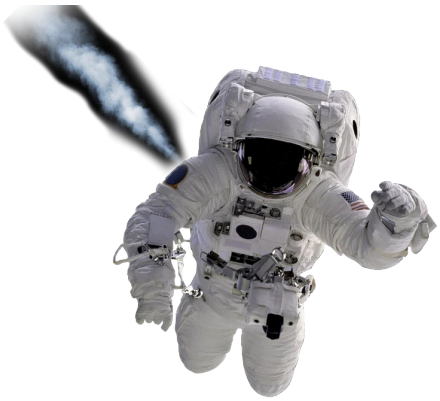
Planet Summary

Year 2022 Month December Day 1 Time 18:06:47 Update Reset to now

	Mercury	Venus	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Right ascension	$17^h\ 24^m\ 7.9^s$	$17^h\ 12^m\ 36.8^s$	$5^h\ 8^m\ 11.8^s$	$23^h\ 57^m\ 4.3^s$	$21^h\ 29^m\ 38.8^s$	$2^h\ 53^m\ 21.3^s$	$23^h\ 33^m\ 43.4^s$	$19^h\ 55^m\ 51.8^s$
Declination	-25° 14' 38"	-23° 23' 57"	24° 56' 16"	-1° 52' 2"	-16° 8' 25"	16° 11' 3"	-4° 8' 57"	-23° 2' 20"
Range (AU)	1.351	1.678	0.545	4.536	10.130	18.766	29.674	35.318
Elongation from Sun	12.8°	9.9°	170.7°	109.4°	70.4°	156.5°	103.1°	47.3°
Brightness	-0.5	-3.8	-1.8	-2.4	0.8	5.6	7.9	14.4
Equatorial Diameter	4.98"	9.94"	17.20"	43.46"	16.41"	3.76"	2.30"	0.09"
Phase Angle	29.4°	13.5°	6.0°	10.8°	5.4°	1.1°	1.8°	1.2°
Constellation	Ophiuchus	Ophiuchus	Taurus	Pisces	Capricornus	Aries	Aquarius	Sagittarius
Meridian transit	12:41	12:30	00:30	19:14	16:47	22:10	18:51	15:14
Rises	06:41	06:30	18:26	13:16	10:48	16:11	12:52	09:15
Sets	18:42	18:30	06:29	01:17	22:47	04:13	00:54	21:13
Altitude	7.9°	5.4°	-4.3°	72.9°	64.6°	27.7°	78.1°	42.0°
Azimuth	244.5°	246.5°	65.0°	96.4°	229.6°	71.7°	110.6°	238.2°
Inferior Conjunction	2022-Sep-23 2023-Jan-07	2022-Jan-09 2023-Aug-13	-	-	-	-	-	-
Opposition	-	-	2020-Oct-13 2022-Dec-08	2022-Sep-26 2023-Nov-03	2022-Aug-14 2023-Aug-27	2022-Nov-09 2023-Nov-13	2022-Sep-16 2023-Sep-19	2022-Jul-20 2023-Jul-22
Superior Conjunction	2022-Nov-08 2023-Mar-17	2022-Oct-22 2024-Jun-04	2021-Oct-08 2023-Nov-18	2022-Mar-05 2023-Apr-11	2022-Feb-04 2023-Feb-16	2022-May-05 2023-May-09	2022-Mar-13 2023-Mar-15	2022-Jan-16 2023-Jan-18
Max. eastern elongation	2022-Aug-27 2022-Dec-21	2021-Oct-29 2023-Jun-04	-	-	-	-	-	-
Max. western elongation	2022-Oct-08 2023-Jan-30	2022-Mar-20 2023-Oct-23	-	-	-	-	-	-
Perihelion	2022-Oct-06 2023-Jan-02	2022-Sep-04 2023-Apr-17	2022-Jun-21 2024-May-08	2011-Mar-17 2023-Jan-20	2003-Jul-26 2032-Nov-28	1966-May-22 2050-Aug-17	1876-Aug-26 2042-Sep-03	1989-Sep-05 2237-Sep-15
Aphelion	2022-Nov-19 2023-Feb-15	2022-May-15 2022-Dec-26	2021-Jul-13 2023-May-30	2017-Feb-17 2028-Dec-28	2018-Apr-17 2047-Jul-15	2009-Feb-27 2092-Nov-23	1959-Jul-17 2125-Dec-01	1866-Jun-04 2114-Feb-19

Fun Astronomy Facts

If your spacesuit started leaking, you could survive for a couple of minutes



Although films such as Total Recall show instant explosions and rapidly puffed-up spacesuits, the effects of being exposed to space are slightly less dramatic.

Although it would definitely be unpleasant, you could survive for a couple of minutes.

After around 10 seconds, you would lose consciousness. The lower pressure of the vacuum would cause your blood to boil, along with other body fluids (the moisture on your tongue, for example) – but this boiling alone would not be fatal due to the pressure maintained by our blood vessels themselves.

Gas bubbles would form in your bodily fluids, causing your body to swell up and bloat. The low humidity of space would cause you to cool down rapidly, and your eyes may freeze over.

Within one to two minutes, the lack of oxygen would be deadly.

The stress of the situation may make these symptoms worse – you would become oxygen-deprived more quickly.

A rapid decompression would cause damage to your lungs, eardrums and sinuses, along with bruising and bleeding from soft tissues.

One teaspoonful of neutron star would weigh the same as the entire human population

A neutron star's density is mind-boggling. These stars are composed almost entirely of neutrons packed together in a tiny radius.

Just a teaspoonful of this material would weigh over a trillion kilograms — more than the weight of the entire human population (which reaches a few hundred billion kilograms).

To make something as dense as a neutron star, the whole of humanity would need to be crammed into a space the size of a sugar cube.

There are stars we will never be able to see

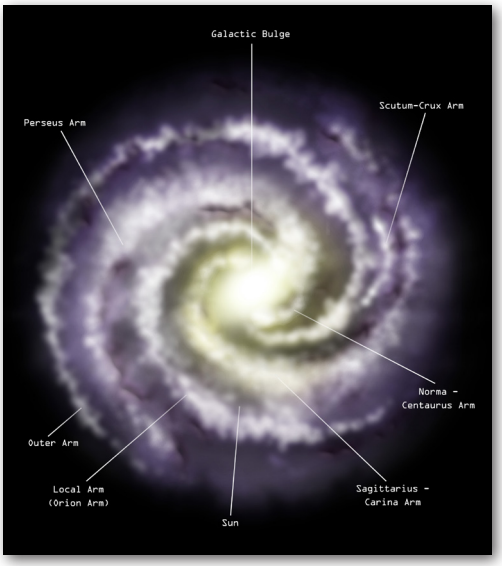
Ever since the Big Bang, most objects in space have been moving away from one another. In fact, the expansion of the Universe is actually accelerating.

As regions of space are whizzing

away from one another at an ever-increasing rate, the first population of stars to form in the Universe are now too far away for us to ever hope of spying them – even using the best present or future telescope.

Hope is not lost; we can attempt to spot them indirectly via the energetic bursts of radiation they emit at the end of their lives.

A long trip



The last time our solar system was in its current position around the Milky Way, the earliest dinosaurs were first roaming the Earth. That's because it takes a whopping 230 million years for our solar system to complete one single orbit around the Milky Way. That really puts that long-day feeling into perspective.