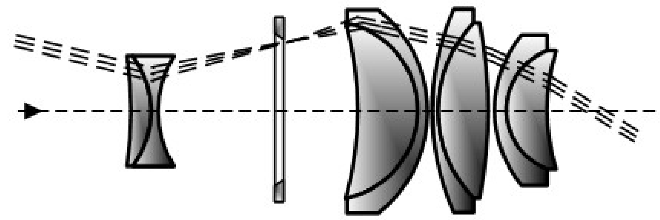
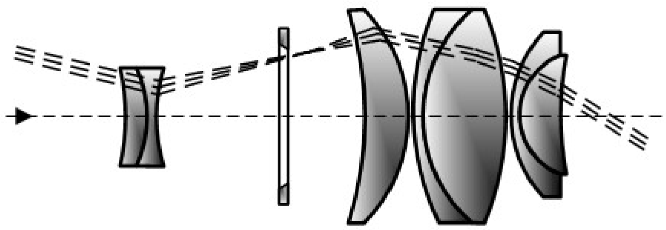
Temecula Valley Astronomer
The monthly newsletter of the Temecula Valley Astronomers   Nov 2020

Events:

Virtual meeting via Zoom on 2 November at 7PM. Join your fellow astronomers for What's Up, IFI and a Mission Highlight. Watch your club email for meeting ID and password.

Until we can resume our monthly meetings, you can also interact with your astronomy associates on Facebook or by posting a message to our mailing list.





Invented by Albert Nagler and patented in 1979, the Nagler eyepiece is a design optimized for astronomical telescopes (Wikipedia)

WHAT'S INSIDE THIS MONTH:

Send newsletter submissions to Mark DiVecchio <markd@silogic.com> by the 20th of the month for the next month's issue.

Like us on Facebook

General information:
Subscription to the TVA is included in the annual $25 membership (regular members) donation ($9 student; $35 family).

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Cosmic Comments
by President Mark Baker

It's at this time of year where I usually become retrospective of the last year of TVA activity in general…but this year is unlike any other!!!

Usually, we have our AGM every November, wherein we vote on the BOD for the upcoming calendar year… however, I'm applying an executive order and asking the 2020 BOD to carry over into 2021. It's not like we haven't accomplished anything perhaps, but the promise of 2020 has been relegated to "virtual" activity for the most part… and has left a taste of dissatisfaction in my mouth at best. Of course, any current board member is free to choose not to continue, but I hope they will… I'd like us to successfully "ride off into the sunset" together at the end of a true tenure!!!

I'm grateful for those that have stepped up and helped fill us with some understanding, and instilled a desire to understand even more. Some have supported the Friday night Star Parties at South Coast Winery. Many have taken this year to improve their individual skills, as the Club gallery will attest… this is something I hope to continue to build on in the future. We should hope to always do more, always do better, and keep the focus on Looking Up… in actuality or virtually!!!

Regardless, I personally want to thank all of you that make these revolutions around the Sun so edifying and enjoyable…this "old dog" is still learning new "tricks", all thanks to you!!!

So, as this November may or may not bring change, I hope it will serve to reinforce the constant that TVA remains…and its contributions are still manifest, ever improving, and ever inspiring.

Clear, Dark Skies my Friends…

Looking Up Redux
compiled by Clark Williams

from these sources:
SeaSky.org
Wikipedia.com
in-the-sky.org
The American Meteor Society, Ltd.
cometwatch.co.uk
NASA.gov
TVA App (2.0.1296)
FullAndNewMoon App (2.0)
Starry Night Pro Plus 7 (7.6.3.1373)
SkySafari 6 Pro (6.1.1)
Stellarium (0.18.2)
timeanddate.com/astronomy
https://www.fourmilab.ch/earthview/pacalc.html

ALL TIMES ARE LOCAL PACIFIC TIME UNLESS NOTED OTHERWISE

Times are given in 24-hour time as: (hh is hours, mm minutes, ss seconds)
hh:mm:ss or hhmmss
hhmm+ (time of the next day)
hhmm− (time of the previous day)
hhmm (seconds not shown)
yyyymmddThhmmss (Full date as: year month day Time separator hours minutes seconds)

Moon Phases for the month by phase:

Saturday the 21st @ 2046 FIRST QTR in AQUARIUS
Monday the 30th @ 0130 FULL in TAURUS
Sunday the 8th @ 0547 THIRD QTR in CANCER
Saturday the 14th @ 2108 NEW in LIBRA

Apogee comes on 2020-11-26 @ **1630 – 405,890 km (252,209 mi)**
Perigee comes on 2020-11-14 @ **0349 – 357,836 km (222,350 mi)**

2020 has: (12) new moons, (13) 1st Qtr moons, (13) Full moons, (12) 3rd Qtr moons (1) Blue moon and (0) Black moons

Daylight Savings: Starts: 2020-Mar-08 : Ends: 2020-Nov-01

Luna: Luna is 97% illuminated on the 1st of the month heading toward 3rd quarter on the 8th. Luna is transiting at **0008+** setting by **0702+**. Luna by mid-month is a Waning Crescent, 1.4% illuminated. Rising early at **0648** and setting in the afternoon at **1728**. By the-end-of-the-month Luna is again Waxing Gibbous, 99% illuminated setting by **0747+**.

Highlights: (distilled from: **SeaSky.org** and **Clark's planetary Orrey** program[s]**)**

November 10 - Mercury at Greatest Western Elongation. The planet Mercury reaches greatest western elongation of 19.1º from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

November 11, 12 - Northern Taurids Meteor Shower. The Northern Taurids is a long-running minor meteor shower producing only about 5-10 meteors per hour. This shower is, however, famous for producing a higher than normal percentage of bright fireballs. The Northern Taurids is produced by dust grains left behind by Asteroid 2004 TG10. The shower runs annually from October 20 to December 10. It peaks this year on the the night of the 11th and morning of the 12th. The thin crescent moon will not be much of a problem this year leaving dark skies for what could be a really good show. Best viewing will be just after midnight from a dark location far away from city lights. Meteors will radiate from the constellation Taurus, but can appear anywhere in the sky.

November 14 - New Moon. The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at **2108**. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

November 16, 17 - Leonids Meteor Shower. The Leonids is an average shower, producing up to 15 meteors per hour at its peak. This shower is unique in that it has a cyclonic peak about every 33 years where hundreds of meteors per hour can be seen. That last of these occurred in 2001. The Leonids is produced by dust grains left behind by comet Tempel-Tuttle, which was discovered in 1865. The shower runs annually from November 6-30. It peaks this year on the night of the 16th and morning of the 17th. The crescent moon will set early in the evening leaving dark skies for what should be an excellent show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Leo, but can appear anywhere in the sky.

November 30 - Full Moon. The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at **0130**. This full moon was known by early Native American tribes as the Beaver Moon because this was the time of year to set the beaver traps before the swamps and rivers froze. It has also been known as the Frosty Moon and the Dark Moon.

November 30 - Penumbral Lunar Eclipse. A penumbral lunar eclipse occurs when the Moon passes through the Earth's partial shadow, or penumbra. During this type of eclipse the Moon will darken slightly but not completely. The eclipse will be visible throughout most of North America, the Pacific Ocean, and northeastern Asia including Japan. (NASA Map and Eclipse Information)

Algol minima: (All times Pacific Time)

11/01/2020	1056
11/04/2020	0744
11/07/2020	0433
11/10/2020	0122
11/12/2020	2211
11/15/2020	1900
11/18/2020	1549
11/21/2020	1238
11/24/2020	0927
11/27/2020	0616
11/30/2020	0305

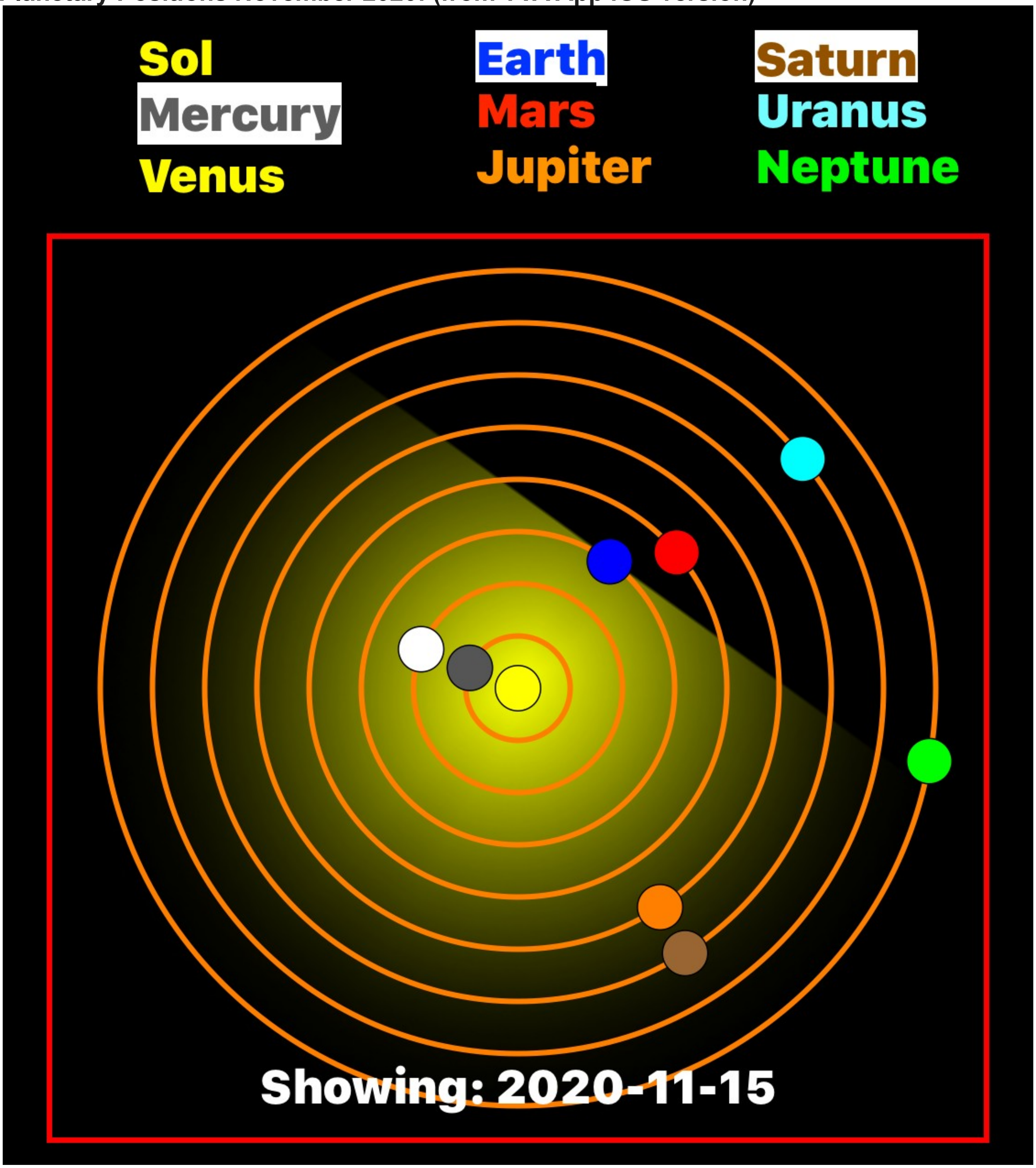
All times PDT
Ephemeris data for Sun

Local Time	Az	Alt	Constel	Rise	Transit	Set
20201101	188° 49.445'	41° 10.317'	Libra	06:07	11:32	16:57
20201102	188° 46.323'	40° 51.645'	Libra	06:07	11:32	16:56
20201103	188° 43.011'	40° 33.240'	Libra	06:08	11:32	16:55
20201104	188° 39.513'	40° 15.110'	Libra	06:09	11:32	16:55
20201105	188° 35.828'	39° 57.259'	Libra	06:10	11:32	16:54
20201106	188° 31.959'	39° 39.695'	Libra	06:11	11:32	16:53
20201107	188° 27.907'	39° 22.424'	Libra	06:12	11:32	16:52
20201108	188° 23.674'	39° 05.452'	Libra	06:13	11:32	16:51
20201109	188° 19.263'	38° 48.785'	Libra	06:14	11:32	16:51
20201110	188° 14.677'	38° 32.429'	Libra	06:15	11:32	16:50
20201111	188° 09.917'	38° 16.391'	Libra	06:16	11:32	16:49
20201112	188° 04.986'	38° 0.678'	Libra	06:17	11:33	16:49
20201113	187° 59.889'	37° 45.294'	Libra	06:17	11:33	16:48
20201114	187° 54.628'	37° 30.247'	Libra	06:18	11:33	16:47
20201115	187° 49.209'	37° 15.541'	Libra	06:19	11:33	16:47
20201116	187° 43.636'	37° 01.183'	Libra	06:20	11:33	16:46
20201117	187° 37.915'	36° 47.178'	Libra	06:21	11:33	16:46
20201118	187° 32.052'	36° 33.533'	Libra	06:22	11:34	16:45
20201119	187° 26.050'	36° 20.252'	Libra	06:23	11:34	16:45
20201120	187° 19.916'	36° 07.342'	Libra	06:24	11:34	16:44
20201121	187° 13.652'	35° 54.806'	Libra	06:25	11:34	16:44
20201122	187° 07.262'	35° 42.652'	Libra	06:26	11:35	16:44
20201123	187° 00.751'	35° 30.882'	Scorpius	06:27	11:35	16:43
20201124	186° 54.120'	35° 19.503'	Scorpius	06:28	11:35	16:43
20201125	186° 47.375'	35° 08.518'	Scorpius	06:29	11:36	16:43
20201126	186° 40.517'	34° 57.932'	Scorpius	06:29	11:36	16:42
20201127	186° 33.550'	34° 47.749'	Scorpius	06:30	11:36	16:42
20201128	186° 26.478'	34° 37.973'	Scorpius	06:31	11:37	16:42
20201129	186° 19.305'	34° 28.607'	Ophiuchus	06:32	11:37	16:42
20201130	186° 12.033'	34° 19.655'	Ophiuchus	06:33	11:37	16:42

All times PDT
Ephemeris data for The Moon

Local Time	Az Alt	RA Dec Kind	Constel	Rise	Transit	Set	Distance	Illumination
2020-11-01	093° 04.251'	36° 57.816'	Taurus	17:49	00:52	07:59	400648.9 km	97.57%
2020-11-02	083° 33.908'	29° 6.118'	Taurus	18:25	01:38	08:56	399515.3 km	93.80%
2020-11-03	075° 31.969'	20° 30.180'	Taurus	19:05	02:27	09:53	397851.9 km	88.36%
2020-11-04	068° 26.740'	11° 23.248'	Gemini	19:51	03:19	10:47	395602.1 km	81.38%
2020-11-05	061° 51.840'	02° 2.015'	Gemini	20:43	04:11	11:38	392724.8 km	73.05%
2020-11-06	055° 23.193'	-8° 6.609'	Cancer	21:41	05:05	12:24	389220.3 km	63.61%
2020-11-07	048° 34.758'	-18° 12.400'	Cancer	22:43	05:57	13:06	385155.6 km	53.36%
2020-11-08	040° 52.379'	-28° 24.090'	Leo	23:47	06:49	13:45	380684.2 km	42.67%
2020-11-09	031° 23.594'	-38° 26.937'	Leo	00:54	07:40	14:20	376055.6 km	32.01%
2020-11-10	018° 41.279'	-47° 50.190'	Virgo	02:02	08:30	14:54	371608.0 km	21.94%
2020-11-11	000° 34.490'	-55° 29.599'	Virgo	02:02	08:30	14:54	367739.8 km	13.10%
2020-11-12	335° 44.193'	-59° 30.525'	Virgo	03:11	09:21	15:29	364858.1 km	6.15%
2020-11-13	308° 34.903'	-58° 3.487'	Libra	04:22	10:14	16:04	363310.4 km	1.66%
2020-11-14	286° 37.158'	-51° 36.196'	Libra	05:34	11:09	16:44	363314.5 km	0.03%
2020-11-15	271° 19.117'	-42° 10.958'	Scorpius	06:48	12:08	17:28	364908.3 km	1.36%
2020-11-16	260° 33.295'	-31° 23.570'	Ophiuchus	08:01	13:10	18:19	367936.7 km	5.46%
2020-11-17	252° 25.844'	-20° 6.547'	Sagittarius	09:11	14:13	19:15	372080.7 km	11.90%
2020-11-18	245° 46.720'	-8° 47.119'	Sagittarius	10:13	15:15	20:16	376918.3 km	20.10%
2020-11-19	239° 52.727'	02° 35.008'	Capricornus	11:07	16:13	21:19	381995.5 km	29.47%
2020-11-20	234° 13.350'	13° 13.230'	Capricornus	11:52	17:07	22:22	386890.1 km	39.45%
2020-11-21	228° 21.681'	23° 37.222'	Aquarius	12:30	17:56	23:22	391256.9 km	49.58%
2020-11-22	221° 47.090'	33° 35.257'	Aquarius	13:03	18:41	0:20	394851.9 km	59.47%
2020-11-23	213° 46.483'	42° 59.544'	Aquarius	13:33	19:24	01:16	397537.9 km	68.80%
2020-11-24	203° 11.639'	51° 34.200'	Cetus	14:00	20:04	02:11	399277.7 km	77.32%
2020-11-25	188° 17.432'	58° 44.683'	Cetus	14:26	20:44	03:05	400117.0 km	84.78%
2020-11-26	167° 21.028'	63° 23.926'	Pisces	14:53	21:24	04:00	400162.2 km	90.96%
2020-11-27	142° 05.978'	64° 5.770'	Aries	15:21	22:06	04:55	399555.4 km	95.66%
2020-11-28	119° 10.441'	60° 28.099'	Taurus	15:51	22:49	05:52	398448.0 km	98.71%
2020-11-29	102° 26.035'	53° 41.667'	Taurus	16:25	23:35	06:50	396977.9 km	99.96%
2020-11-30	090° 52.242'	45° 5.237'	Taurus	17:04	00:24	07:47	395250.8 km	99.30%

Planets:
Planetary Positions November 2020: (from TVA App iOS version)



- **Mercury:** Mercury is a morning object in the beginning of the month. It is illuminated at 19% and 1.07 apparent magnitude. Mercury rises at: **0503** and sets by **1621** with sunrise following at **0607**. Mercury will be at Greatest Western Elongation on the 10th of the month. By mid-month the Winged Messenger is rising at **0451** with sunrise following at **0619**. On the 30th, Mercury is rising at **0542** preceding sunrise at **0633**.

- **Venus:** Is the "Morning Star" in the beginning of the month, rising at **0323** preceding sunrise at **0607**. By mid-month Venus rises at **0349** followed by Sol at **0619**. By the 30th Venus is rising at **0419**. followed by sunrise at **0633.**
- **Mars:** Mars is still prominent this month, rising at 1**547** on the 1st of the month, transiting at **2203** and not setting until **0419+**. By mid-month Mars is rising at **1448** transiting at **2103** (perfect time for imaging) and doesn't set until 0320. Mars is still high in the sky at 61.5° which is great for getting into planetary imaging. End-of-month finds the Warrior rising at **1349** but transit is at **2010** and doesn't set until **0231+**.
- **Jupiter:** On the first of the month Jove rising at **1133** and transiting at **1633** but doesn't set until **2134**. Jupiter is disappointingly low in the sky at about 31°. There is a Full Moon to the east of Jupiter but it is more than 125° away. You should be able t get some good viewing in even with the Moon. By mid-month Jupiter is still visible but it is fading fast, setting at **2050**. So quick views in the late evening is all you're going to get. There will be no Moon in sight. Saturn is about 3° to the east of Jupiter. Come the end of month Jupiter is peaking above the horizon by **1704**. However the Moon is Full.
- **Saturn:** Saturn is trailing Jupiter and Pluto; rising about **1151** on the 1st. The moon is Full. Saturn by mid month is transiting at **1604**, and setting at **2108**. Like Jupiter, Saturn is fading fast. Not to return until June of 2021. By the end-of-the-month Saturn is transiting at **1510** and setting at **2015**. See Jupiter for the Moon interference.
- **Uranus:** On the first Uranus rises at **1645**. The apparent magnitude is 5.66 so we're on the ragged edge of being naked-eye visible. The Astronomer's Bane will be 98% illuminated, 16° to the east so you may not be able to eek out a view. By the ides Uranus is rising at **1548**, transiting at **2229** and not setting until **0509+** (sunrise is at **0619**). End of the month and the "sky god" is rising at **1447** while a Waxing gibbous 99% illuminated Moon glares away 40° to the east.
- **Neptune:** Neptune is leading Uranus. Neptune is rising at **1432** in the beginning of the month. Transiting at **2020** and not setting until **0208+**. There is a Full Moon 69° eastward of Neptune. By the 15th Neptune is transiting at **1924** and setting at **0112+**. The Moon is New and it is a great time for imaging Neptune. Neptune is about 47° altitude so it is high in the sky and away from the annoying low altitude gunk in the sky. By the end of the month Neptune is transiting at **1825** and setting at **0013+**. The Moon is 90° eastward with 99% illumination.
- **Pluto:** On the first of the month Pluto is lost to the glare of them Moon. By mid-month Pluto is transiting by **1546** and is in a great grouping with Saturn and Jupiter . Pluto doesn't set until **2046** but the apparent magnitude 14.41 will make it difficult to see. You'll need omething in the 25.4 cm . By the 30th Pluto doesn't set until **1948** but the pesky Moon is right where you do not want it to be, shinning at 99%.

Asteroids:

- Still a dearth of asteroids. I searched for asteroids in 2020 with a reasonable magnitude; say less than or equal to +10 in November there are a few beyond the regulars: Juno, Vesta. Hebe, Eros and Herculina. So consult your local planetarium software for more or try: https://www.asteroidsnear.com/year?year=2020

(1) Ceres Dwarf Planet in Aquarius 1st -- 30th rising: mag 8.9 – is the largest and most massive asteroid in the inner Solar System.
(2) Pallas Asteroid in Hercules 1st – 30th rising: mag 10.6 – the second largest asteroid in the inner Solar System and the largest body in the Solar System not to be rounded by its own gravity.

Meteors:

- See Highlights above for more details. (SeaSky.org**)** (American Meteor Society)

Comets: come in various classifications:

- 1) Short Period comets – further broken down into:
  - Halley Type: The Halley Types are believe to come from the Kuiper Belt and have periods in excess of 20-years.
  - Jupiter Type: The Jupiter types have a period less than or equal to 20-years.
  - Short period comets have a near circular orbit or an elliptical orbit. The latter being far more common.
- 2) Long Period comets – thought to originate from the Oort cloud these comets have periods of over 200 years and have random inclinations around the celestial sphere.

ESTIMATES ONLY

Local time 2100 PDT

None below 9.0 Apparent Magnitude

Deep Sky:
Notes:
L/Z abbreviation for ALT/AZ
R/D abbreviation for Right Ascension/Declination
α is right ascension
δ is declination
In each case, unless otherwise noted, you should look for the following on or about the 15th Day of November 2020 at 2100 PDT and you will have about 20 minutes of viewing time total.

- Maia Nebula in M45

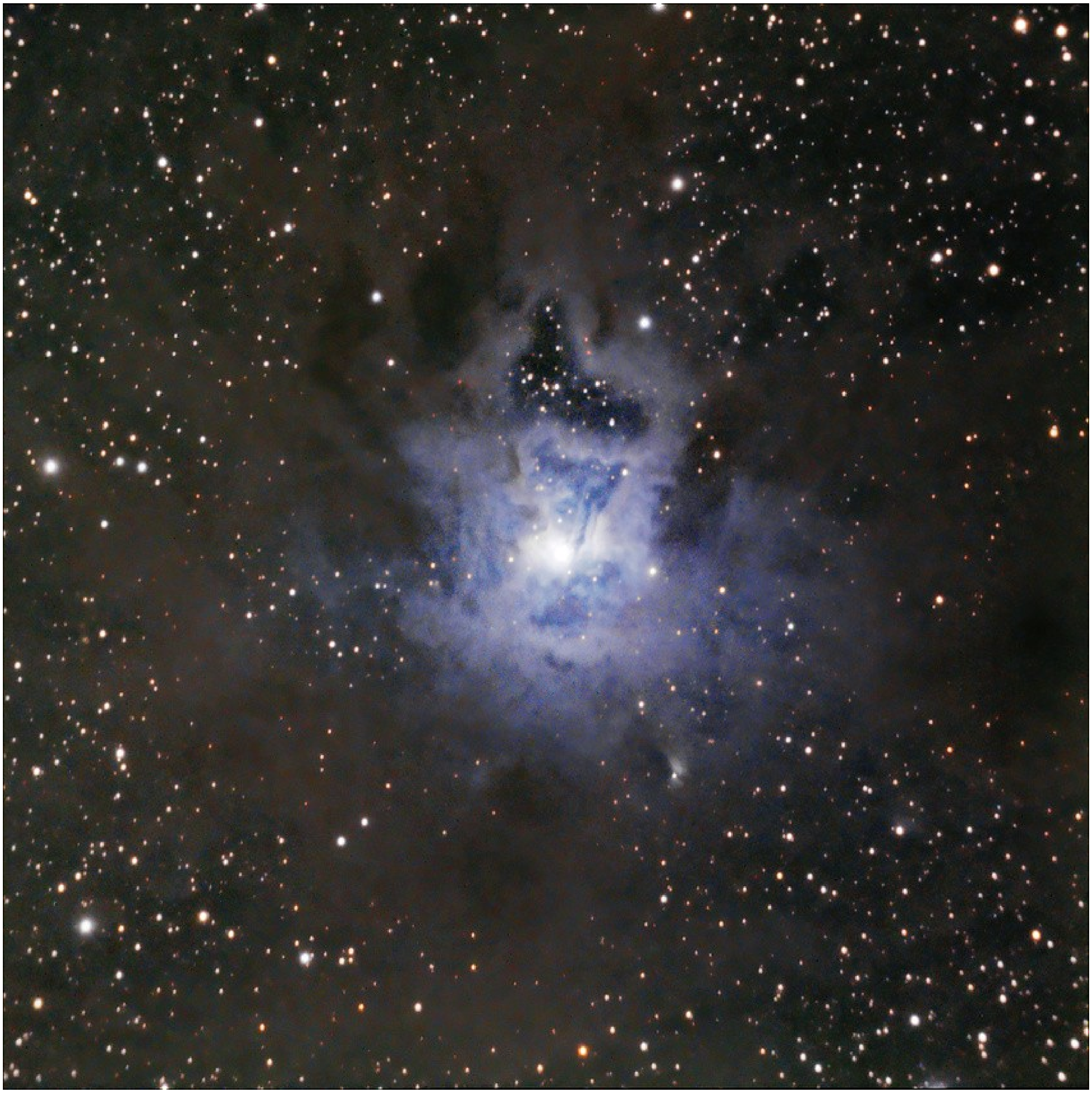
Maia /ˈmeɪə/, designated 20 Tauri (abbreviated 20 Tau), is a star in the constellation of Taurus. It is a blue giant of spectral type B8 III, a chemically peculiar star, and the prototype of the Maia variable class of variable star.

Maia is the fourth-brightest star in the Pleiades open star cluster (Messier 45), after Alcyone, Atlas and Electra. It is surrounded by one of the brighter reflection nebulae within the Pleiades, designated NGC 1432 and sometimes called the Maia Nebula.

Nomenclature

The name Maia originates with the Greek: *Μαῖα* and Latin: *Maia*. Maia is one of the seven daughters of Atlas and Pleione in Greek mythology—stars which are also included in the Pleiades star cluster. In 2016, the International Astronomical Union organized a Working Group on Star Names (WGSN) to catalog and standardize proper names for stars. The WGSN's first bulletin of July 2016 included a table of the first two batches of names approved by the WGSN; which included Maia for this star. It is now so entered in the IAU Catalog of Star Names. (Wikipedia)

- **Iris Nebula**



By Hewholooks - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6886265

- I haven't seen anyone try this nebula. It is quite stunning and requires some care to get the processing and imaging correct. – The Iris Nebula (also known as NGC 7023 and Caldwell 4) is a bright reflection nebula in the constellation Cepheus. The designation NGC 7023 refers to the open cluster within the larger reflection nebula designated LBN 487. The nebula, which shines at magnitude +6.8, is illuminated by a magnitude +7.4 star designated SAO 19158. It is located near the Mira-type variable star T Cephei, and near the bright magnitude +3.23 variable star Beta Cephei (Alphirk). It lies 1,300 light-years away and is six light-years across. (Wikipedia)

November is great for both viewing and imaging. Spend some time outside with your scope. Autumn Nebulae are in full bloom.

For now – Keep looking up.

Random Thoughts – Eyepieces Mostly
by Chuck Dyson

Last month I gave my opinions on binoculars but left out two things in the interest of brevity.

The first item is my favorite binoculars of all time are the Walmart, Amazon or Big Five $10.99 10 X 25 specials. Although Galileo's first telescopes had field lenses larger then my 25 mm binocular the field lens was stopped down in Galileo's telescopes because of all of the aberrations produced by the edges of a lens at that time, in 1609 lens shaping and polishing was in its infancy. The first Galileo telescopes magnified objects any where from 8X to about 20X; so, my 10 X 25 binocular is a fair approximation of a Galileo scope, quality of the lens included. With my Galileo equivalent binoculars I am ready to repeat his observations that produced the 1610 book *Sidereus Nuncius*, Starry Messenger, and it is quite the feeling to retrace the path, and with these binoculars you can retrace the path, that literally destroyed all of our beliefs about the universe. Awesome!

The second thing that I want to mention is with the holidays approaching stores will stock extra items, including astronomy equipment, for the eager shoppers. Costco is no exception to this rule and always stocks some very entry level telescopes for the holidays both in store and online. Last year they had, online, 20 X 80 SkyMaster Pro binoculars with tripod at a very good price, if you are considering buying a large pair of binoculars you may want to keep an eye on Costco in early December for the reappearance of this offer if it is repeated.

And now on to eyepieces.

Remember that there are three parts to your observing equipment that contribute to that perfect image when observing. The first is the optical tube; if the main objective, be it refractor lens or reflector mirror, does not give a sharp image to the correct focal point, the best eyepiece in the world will not give a sharp image. The next part in our quest to get the perfect image is the eyepiece itself. The job of the eyepiece is to take the converging rays of light that, the telescope has bent, and turn them back into parallel rays of light but magnified. The job of the eyepiece gets harder and harder as the focal ratio (the focal length of the telescope divided by the focal length of the eyepiece) gets smaller and the Apparent Field of View gets bigger. The final component of the perfect image story is your eye, and yes I find it very odd and just a little amusing that in all of the thousands of eyepiece reviews that you can go to on line I have not found one that states the condition of the viewers eye. Astigmatism, asymmetrical cornea, lens, or both; cataracts, lens proteins breaking down and clouding vision; macular degeneration, the gradual breakdown of the vision cones in the center of the retina (this is the area of fine detail vision) are just a few of the optical conditions that will make objects in your new $350 eyepiece look the same as objects in your old $35 eyepiece and render your evaluation paper useless.

It is also helpful to know two other things about your eye: first, you only have a sharp vision cone of 48º because the vision cells are concentrated in the center of the back of your eye (you can easily demonstrate this by simply focusing on a word in the center of one of the lines and the three or four words on either side of the focus word will be in sharp focus and after that they will start to blur more and more the farther the words are from the center word (you must stay focused on the center word for this demonstration to work - if you shift your focus back and forth all words will appear to be in focus); Second, as you get older than 35 the iris in your eye will not open up as far as it once did, this is a gradual thing, and when you reach the "advanced" age of say 70 your iris may only open to 5 millimeters and not the7 millimeters of your youth; so, do not buy an eyepiece that gives you a 7 millimeter cone of light as you will not see it all.

As we now have taken a good look at the eye and this is an article about eyepieces let's actually look at the eyepiece. The "job" of the eyepiece is to produce an image with the following qualities:

- sharpness, all elements in focus no distortion no aberration
- brightness, high throughput of light with light neither scattered nor deflected
- contrast, the luminance difference between the brightest and the dimmest objects in the image
- comfort and convenience, is it easy and comfortable for you to use especially if you must wear eyeglasses.

What we do not want the eyepiece to do is to scatter light all around, producing haze in the view and, in extreme cases, a ghost image, as in you actually see two moons in the eyepiece.

Finally lets look at some of the key parts of the eyepiece so that we may speak a common language.

- The focal length of an eye piece is the distance of the light path from the telescopes focal point to the point where the light exits the eyepiece and heads for your eye.
- The field lens is the first lens in the eyepiece that lets the light from the telescope into the eyepiece.
- The eye lens is the last lens in the eyepiece that lets the light out so that it can get to your eye.
- The apparent field of view (AFOV) is the angular diameter of light visible just through the eyepiece in degrees.
- The true field of view (TFOV) is the actual angle of the sky you see when the eyepiece is in the telescope in degrees.
- The field stop is a plate in the back of the eyepiece with a hole in it to let the telescope cone of light through and block unwanted stray light; however, the field stop may reduce the TFOV of the eyepiece.
- The barrel size is the diameter of the part of the eyepiece that goes into the telescope and it is important to know your barrel size because there several "standard" sizes out there. The present barrel sizes that you may encounter are 0.965 inch (old, think 1960ish) eyepieces, 1.25 inch (present popular size) eyepieces, 2 inch (second most popular now) eyepieces, 2.7 inch (I have never seen one but I am told they exist) eyepieces, 3 inch (just the thing if you must have a $1000 eyepiece) eyepiece. 4 inch (the only two that I know of in Southern California are used on the Mt. Wilson 60 inch telescope) eyepiece and yes it is an odd feeling to use an eyepiece that is larger than some refractor telescopes.
- The eye relief is the distance from the eyepiece your eye must be to the telescopic image.

Eyepieces, as we know them today, did not and could not exist for early astronomers, not because early astronomers didn't have the money to buy expensive eyepieces, they did, but rather the technology to produce them did not exist. Today there are seventy different ingredients that can be added to glass to alter its physical characteristics to the optician's specific needs.

In 1609, glass that was optically clear always represented a very small, if any, portion of the glass batch. It was not until Pierre-Louis Guinand in about 1796 developed a method of stirring glass so that larger portions of the glass melt were acceptable for the use in telescopes. To make glass, the different components are mixed together cold and then heated, once molten they were stirred to completely and uniformly mix the ingredients. The problem here is just how to stir molten glass as it is at a temperature of 1500 Celsius and iron melts at 1537 Celsius with the iron atoms imparting a green color to the glass. Their only answer was to use wooden sticks, sticks catch fire at 300 Celsius, for short periods of time and then, after the glass cools, separate the big bits with gas bubbles, discolorations, and burnt bits of wood from the little bits of good glass that would be remelted and formed into glass pillows that could be ground into lenses, an exhausting process. But even with Guinand's improvement the production of quality optical glass was still low. On the brighter side Guinand wound up working with one Joseph Von Fraunhofer and made optical glass from Fraunhofer's glass recipes, gave Fraunhofer the glass that was produced and said, "see what you can do with this". I think we all know how that turned out.

The development of multiple lens eyepieces was slow because it was hard. It was hard to control the quality of your raw material, it was hard to control the temperature of your furnace, and it was hard to exactly control shape of your polished lens. Despite all of this in 1684 Christian Huygens produced a two lens eyepiece that had a AFOV of 20º, hay, it's better than the 10º field of a single lens eyepiece. In 1758, John Dollond produces the first cemented crown and flint eyepiece, as an eyepiece the design is a flop but turns out to be a great way to make the field lens of a telescope. In 1782 Jesse Ramsden produces a two lens eyepiece that is a refigured Huygens wit the same 20º field of view but better control of chromatic aberration. It is not until 1849 that we get our real breakthrough eyepiece, the Kellner by Carl Kellner, this eyepiece has three elements with really good control of chromatic aberration and a field of view of 45º, modern day astronomy has arrived along with ghosting and a slightly dimmer view due to internal light reflection. Eleven years later George Simon Plossl produces his four element 52º AFOV eyepiece, and it is a complete flop because it is so expensive and difficult to manufacture, not to mention the dimming and ghosting that it produces. It is not until the 1960's, with the introduction of lens coatings, to reduce reflections and mechanical lens grinders to produce consistent lenses that the eyepiece is a success. Please do not feel sorry for poor old George because he was very successful as a microscope manufacturer, some of his high end microscopes even had their lenses made from colorless sapphires or high quality diamonds. The last eyepiece that I want to mention is the Erfle; this was invented in 1914, just in time for WWI, and with five lens elements was dimmer and had much more ghosting issues than the Plossl, but, with a 60º AFOV field of view made a most excellent telescopic gun sight. After WWII when lens coatings became generally available and computers were able to help with the lens element design there was the eyepiece design explosion that we are all familiar with and most of us have never actually seen a ghost image in our eyepieces and we have very bright images despite eyepieces with up to nine elements in them, the only bad thing about these eyepieces is the price tag.

This little story has been all well and good, you say, but it has not helped me in any real way to determine what eyepieces I should buy and how many will constitute a basic eyepiece set? You are completely correct of course and, please, let me correct my omission. We will develop an eyepiece set for two observers, a 75 year old man (me) with a maximum pupillary diameter of 5 millimeters and a twenty year old young lady (my granddaughter) with a maximum pupillary diameter of 7 millimeters. We will use two telescopes. Our first is a 5 inch or 127 mm f/5.5 refractor with a focal length of 700 mm and a 2 inch/ 1.25 inch eyepiece holder. Our second is a 6 inch or 150 mm f/10 Schmid-Cassegrain with a focal length of 1500 mm with a 1.25 inch eyepiece holder. My first question is what is the lowest magnification I can use and still see all of the light captured by the telescope. To do this I must find out what eyepiece will produce a 5 mm cone of light in this scope. The answer is simple to get I just take the diameter of the scope in millimeters and divide by 5 mm [127÷5=25.4X] just to be safe I will use an eyepiece that will give me a magnification of 26X and to get that number I divide my telescope focal length in millimeters by my 26X [700÷26=27 mm] I want a 27 mm or slightly shorter eyepiece to see all of the light coming from my scope. How much of the sky do I get to see, my TFOV, to do that I first divide my eyepiece focal length into my telescope focal length to get my magnification {700÷27=26X} and then take my magnification 26X and divide it into my eyepiece AFOV in this case my 27 mm eyepiece has a 52º AFOV and so I get [53÷26=2] a two degree field of view. But what about my grand daughter with a 7 mm pupil? Her numbers are [127÷7=18X] and the focal length of the eyepiece that will give her an 18X times view of our celestial object is {700÷18=39 mm} unfortunately in 1.25 inch barrel eyepieces the eyepiece that gives us the biggest TFOV is only a 32 mm Plossl at 50º AFOV and this gives us a [700÷32=22X] {127÷22=5.7 mm} 5.7 mm cone of light; so, can we ever get an object in the eyepiece that will give a 7 mm cone of light for my granddaughters younger eyes? Yes. Remember the refractor has a 1.25/2 inch convertible eyepiece and with a 2 inch eyepiece the game changes, let's see how. In my 2 inch eyepiece collection I do have a 38 mm focal length eyepiece with a 70º AFOV and let's see how this one works out. First [700÷38=18X} and I now take my 18X and divide it into my 127 mm objective diameter and {127÷18=7 mm} a seven millimeter cone of light but what is her TFOV with this 2 inch eyepiece, well I divide my 18X into my eyepiece AFOV in this case 70º [70÷18=3.9] that's a 3.9º field of view, almost a finder scope field of view, no wonder 2 inch eyepieces are so popular. Now what is the highest magnification I want and what is the eyepiece to give it to me. As we magnify objects in the eyepiece we spread out the light more and more and the object gets dimmer and dimmer; therefore, the upper limit of magnification will be the point at which the object is so dim detail of it is not observable and in practice this is when the cone of light in the eyepiece is about ½ mm or the telescopes object diameter, in millimeters, times 2 in our case that is a magnification of 254X, have I ever pushed my scope to this limit, no, by the way, I do have a 4.7 mm eyepiece that will give me a 149X view and that is as far as I would ever go but for the sake of this paper let us see what focal length eye piece will give us 254X in this scope. The formula is my focal length divided by the magnification gives the eyepiece focal length [700÷254=2.7 mm] now there are 2 mm, 3 mm and 5 mm eyepieces out there so you can really have yourself a ball magnifying objects. Now in the case of the 150 mm Schmid-Cassegrain because of the long focal length I will take off the 1.25 inch diagonal and replace it with a 2 inch diagonal but when

I take off the diagonal I find that the eyepiece aperture port is only 32 mm in diameter (in millimeters 1.25 inches is 31.75 mm and 2 inches is 50.8 mm) so this scope has an eyepiece aperture port that acts as a field stop and will only permit the use of 1.25 inch eyepieces. So, how much of the sky can we see with this set-up. We will use our 32 mm focal length Plossl with the 50º AFOV and see what we get; first our magnification formula {1500÷32=47X} then our TFOV formula [50÷47=1.1º] because of our long focal length and 1.25 eyepiece we only see 1.1º of actual sky.

How does all of this help you buy eyepieces wisely? First you should figure out what type of viewing you will most likely want to do and then buy a telescope that will accommodate your viewing goals. Second work out what your eyes can and cannot see. Third set your upper and lower limit of eyepieces, you may not get this exactly right on the first try as your observing goals may change and yes mine have several times, but that's OK because that's why we have eBay. Fourth once you have your upper and lower limits for eyepieces you can fill in the middle, I have a five eyepiece minimum high power, medium high power, medium, medium low power, and low power. Depending on what I plan to observe I may bring extra eyepieces; if tonight is to be planetary nebula night I may bring extra eyepieces in the high power range and if its open clusters then extras in the low power range.

But the real message is
"Take your stuff outside and observe"

Now that my eyepiece collection is complete🤪I will actually buy a telescope😂

Cheers, Chuck

The International Space Station: 20 Continuously Crewed Years of Operation
by David Prosper

Did you know that humans have been living in the International Space Station, uninterrupted, for twenty years? Ever since the first crew members docked with the International Space Station (ISS) in November 2000, more than 240 people have visited this outpost, representing 19 countries working together. They have been busy building, upgrading, and maintaining the space station - while simultaneously engaging in cutting-edge scientific research.

The first modules that would later make up the ISS were launched into orbit in 1998: the Russian Zarya launched via a Proton-K rocket, and the US-built Unity module launched about a week and a half later by the Space Shuttle Endeavour. Subsequent missions added vital elements and modules to the Space Station before it was ready to be inhabited. And at last, on November 2, 2000, Expedition-1 brought the first three permanent crew members to the station in a Russian Soyuz capsule: NASA astronaut William M. Shepherd and Russian cosmonauts Sergei Krikalev and Yuri Gidzenk. Since then, an entire generation has been born into a world where humans continually live and work in space! The pressurized space inside this modern engineering marvel is roughly equal to the volume of a Boeing 747, and is sometimes briefly shared by up to 13 individuals, though the average number of crew members is 6. The unique microgravity environment of the ISS means that long-term studies can be performed on the space station that can't be performed anywhere on Earth in many fields including space medicine, fluid dynamics, biology, meteorology and environmental monitoring, particle physics, and astrophysics. Of course, one of the biggest and longest experiments on board is research into the effects of microgravity on the human body itself, absolutely vital knowledge for future crewed exploration into deep space.

Stargazers have also enjoyed the presence of the ISS as it graces our skies with bright passes overhead. This space station is the largest object humans have yet put into orbit at 357 feet long, almost the length of an American football field (if end zones are included). The large solar arrays – 240 feet wide - reflect quite a bit of sunlight, at times making the ISS brighter than Venus to observers on the ground! Its morning and evening passes can be a treat for stargazers and can even be observed from brightly-lit cities. People all over the world can spot the ISS, and with an orbit only 90 minutes long, sometimes you can spot the station multiple times a night. You can find the next ISS pass near you and receive alerts at sites like NASA's Spot the Station website (spotthestation.nasa.gov) and stargazing and satellite tracking apps.

Hundreds of astronauts from all over the world have crewed the International Space Station over the last two decades, and their work has inspired countless people to look up and ponder humanity's presence and future in space. You can find out more about the International Space Station and how living and working on board this amazing outpost has helped prepare us to return to the Moon - and beyond! - at nasa.gov.

The ISS photobombs the Sun in this amazing image taken during the eclipse of August 21, 2017 from Banner, Wyoming. Photo credit: NASA/Joel Kowsky More info: bit.ly/eclipseiss

A complete view of the ISS as of October 4, 2018, taken from the Soyuz capsule of the departing crew of Expedition 56 from their Soyuz capsule. This structure was built by materials launched into orbit by 37 United States Space Shuttle missions and 5 Russian Proton and Soyuz rockets, and assembled and maintained by 230 spacewalks, with more to come! Credit: NASA/Roscosmos More info: bit.ly/issbasics

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