



Temecula Valley Astronomer

The monthly newsletter of the Temecula Valley Astronomers Dec 2020

Events:

Virtual meeting via Zoom on 7 December at 7PM. Join your fellow astronomers for IFI and a Gallery. Dr Breann Sitarski, formerly of the Galactic Center Group, will present on her current project as Optical Systems Scientist for the Giant Magellan Telescope. Annette Brown will again provide virtual refreshments. 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.



NASA APOD : NGC 6822: Barnard's Galaxy
Image Credit & Copyright: Data - [Martin Pugh](#), Processing - [Mark Hanson](#)

General information:

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

President: Mark Baker 951-691-0101

<shknbk13@hotmail.com>

Vice President: Sam Pitts <sam@samsastro.com>

Past President: John Garrett <garrjohn@gmail.com>

Treasurer: Curtis Croulet <calypte@verizon.net>

Secretary: Deborah Baker <geedeb@gmail.com>

Club Librarian: Vacant

Facebook: Tim Deardorff <tim-deardorff@yahoo.com>

Star Party Coordinator and Outreach: Deborah Baker
<geedeb@gmail.com>

Address renewals or other correspondence to:

Temecula Valley Astronomers

PO Box 1292

Murrieta, CA 92564

Members' Mailing List:

<tvastronomers@googlegroups.com>

Website: <http://www.temeculavalleyastronomers.com/>

WHAT'S INSIDE THIS MONTH:

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by President Mark Baker

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compiled by Clark Williams

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by Chuck Dyson

Visitors to Both Jupiter and Saturn

by David Prosper

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

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Cosmic Comments by President Mark Baker

This has been a hard year in so many ways, but in some ways it has been full of exciting times in the study of the Cosmos, near and far...we glean new insights daily, and are even doing what was once the impossible on a daily basis. And the best part again, is that there is plenty of room for amateurs and hobbyists to be involved and make hard contributions...from corroborative observing to validating data, amateurs like us are an important cog in the wheel of understanding!!!

I have made a plethora of suggestions on how people can pursue an interest and actually contribute to research and corroboration... but I must confess, I doubt few follow up. It's a sad trend in the USA it appears, even in areas of intense interest...

A point to all this for us non-professionals, is the need for more "eyes" on the skies grows exponentially... the professionals cannot do it alone. I again encourage any and all that might have a spare hour or two, now and then, to jump into [Zooniverse](#), google NASA and commercial agencies, or even international organizations to see where your particular interests might best fit and best be utilized. There is so much to be done and the work can be gratifying...you might even find your name attached to one or more of the plethora of papers being produced constantly. For example, an easy contribution still is the Silent Earth project...if you take and submit only 100 readings on your smart phone, you become part of that research team!!! Fun stuff...

But coming back down to Earth, the TVA still continues to inspire and encourage young and old alike to Look Up, wonder in awe, and ask important questions...in spite of all the obstacles 2020 has provided. That part of our Mission never changes...

Thanks to all those that actively support this effort, as well as those that tacitly do so just by being a part of TVA...hopefully we can commune in person more but still use the virtual engagements to enhance our experiences. On to 2021...!!!

Clear, Dark Skies my Friends...





Looking Up Redux compiled by Clark Williams

from these sources:

SeaSky.org

[Wikipedia.com](https://www.wikipedia.com)

[in-the-sky.org](https://www.in-the-sky.org)

The American Meteor Society, Ltd.

[cometwatch.co.uk](https://www.cometwatch.co.uk)

[NASA.gov](https://www.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:

Monday	the 21 st	@ 1542 FIRST QTR in CETUS
Tuesday	the 29 th	@ 1929 FULL in GEMINI
Monday	the 7 th	@ 1637 THIRD QTR in LEO
Monday	the 14 th	@ 0817 NEW in OPHIUCHS

Apogee comes on 2020-12-24 @ 0833 – 405,009 km (251,661 mi)

Perigee comes on 2020-12-12 @ 1243 – 361,776 km (224,797 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 Full on the 1st on the month. Luna is transiting at 0015+ setting by 0843+. Luna by mid-month is a Waxing Crescent, 2.7% illuminated. Rising at 0753 and setting in the afternoon at 1756. By the-end-of-the-month Luna is Waning Gibbous, 98% illuminated setting by 0821.



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

December 13, 14 - **Geminids Meteor Shower.** The Geminids is the king of the meteor showers. It is considered by many to be the best shower in the heavens, producing up to 120 multicolored meteors per hour at its peak. It is produced by debris left behind by an asteroid known as 3200 Phaethon, which was discovered in 1982. The shower runs annually from December 7-17. It peaks this year on the night of the 13th and morning of the 14th. The morning of the 15th could also be nearly as active this year. The nearly new moon will ensure 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 Gemini, but can appear anywhere in the sky.

December 14 - **New Moon.** The Moon will be located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at **0817**. 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.

December 14 - **Total Solar Eclipse.** A total solar eclipse occurs when the moon completely blocks the Sun, revealing the Sun's beautiful outer atmosphere known as the corona. The path of totality will only be visible in parts of southern Chile and southern Argentina. A partial eclipse will be visible in most parts of southern South America, the southeastern Pacific Ocean and the southern Atlantic Ocean.
(NASA Map and Eclipse Information) (NASA Interactive Google Map)

December 21 - **December Solstice.** The December solstice occurs at **0202**. The South Pole of the earth will be tilted toward the Sun, which will have reached its southernmost position in the sky and will be directly over the Tropic of Capricorn at 23.44 degrees south latitude. This is the first day of winter (winter solstice) in the Northern Hemisphere and the first day of summer (summer solstice) in the Southern Hemisphere.

December 21 - **Rare Conjunction of Jupiter and Saturn.** A conjunction of Jupiter and Saturn will take place on December 21. This rare conjunction of these two planets is known as a great conjunction. The last great conjunction occurred in the year 2000. The two bright planets will appear only 7 arc minutes of each other in the night sky. They will be so close that they will appear to make a bright double planet. Look to the west just after sunset for this impressive and rare planetary pair.

December 21, 22 - **Ursids Meteor Shower.** The Ursids is a minor meteor shower producing about 5-10 meteors per hour. It is produced by dust grains left behind by comet Tuttle, which was first discovered in 1790. The shower runs annually from December 17-25. It peaks this year on the the night of the 21st and morning of the 22nd. The first quarter moon should set just after midnight leaving dark skies for what could be a good show. Best viewing will be just after midnight from a dark location far away from city lights. Meteors will radiate from the constellation Ursa Minor, but can appear anywhere in the sky.



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December 30 - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be fully illuminated. This phase occurs at **1930**. This full moon was known by early Native American tribes as the Cold Moon because this is the time of year when the cold winter air settles in and the nights become long and dark. This moon has also been known as the Long Nights Moon and the Moon Before Yule.

Algol minima: (All times Pacific Time)

12/02/2020	2254
12/05/2020	1943
12/08/2020	1632
12/10/2020	2019
12/11/2020	1321
12/14/2020	1010
12/17/2020	0659
12/20/2020	0349
12/23/2020	0038
12/25/2020	0927
12/28/2020	1816
12/31/2020	1505

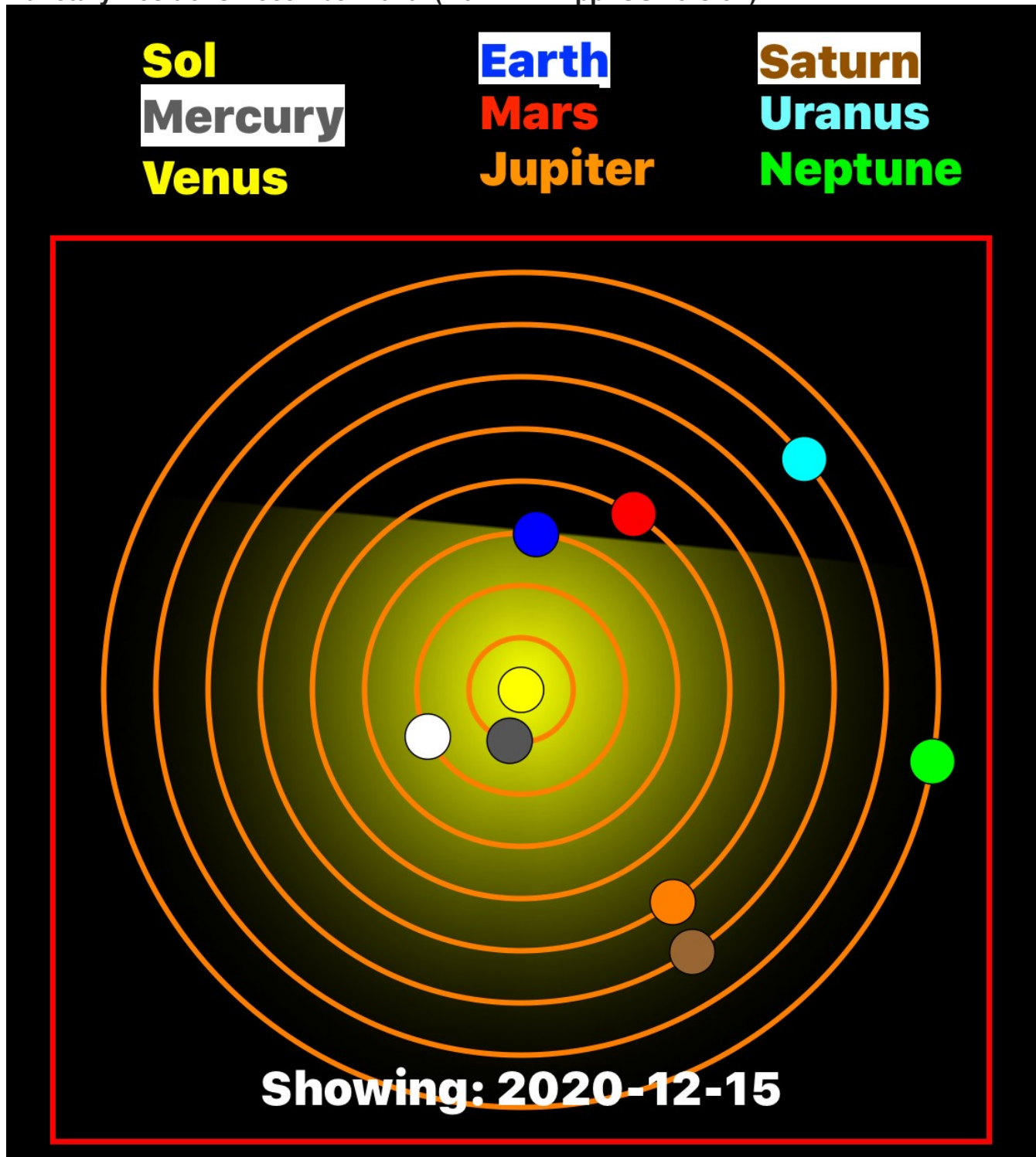


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Planets:

Planetary Positions December 2020: (from TVA App iOS version)



- **Mercury:** Mercury is a morning object in the beginning of the month. It is illuminated at 95% and -0.75 apparent magnitude. Mercury rises at: **0545** and sets by **1605** preceding sunset at



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1642. By mid-month the Winged Messenger is approaching even closer to Sol. Sunset will be at **1644**; Mercury sets at **1629**. On the 31st Mercury is setting at **1718** preceded by sunset at **1553**.

- **Venus:** Is the Morning Star in the beginning of the month, rising at **0421** preceding sunrise at **0634**. By mid-month Venus rises at **0450** followed by Sol at **0644**. By the 31st Venus is rising at **0522**, followed by sunrise at **0651**.
- **Mars:** Mars is rising at **1349** on the 1st of the month, transiting at **2010**. There will be a nearly full moon more than 61° away toward the east. By mid-month Mars is rising at **1446**.,, transiting at **2103** and setting at **0320+**. End-of-month finds the Warrior rising at **1211**, transiting at **1845** and setting by **0120+**.
- **Jupiter:** On the first of the month Jove rising late morning at **0954** and transiting early afternoon at **2001**. There is a Full Moon to the east of Jupiter over 154° away. By mid-month Jupiter is rising at **0909**, transiting by **1414** and setting at **1920** so you will have a little over 2-hours to do some viewing and some imaging. Saturn is about one-half of a degree to the east of Jupiter. Come the end of month Jupiter is peaking above the horizon by **0818**, transiting early afternoon and setting by **1834**. However the Moon is Full.
- **Saturn:** Saturn is trailing Jupiter and Pluto; rising about **1001** on the 1st. The moon is Full but on the other side of the sky. Saturn sets at **2012**. Saturn by mid month is rising by **0911**, transiting at **1417** but not setting until **1923**. By the end-of-the-month Saturn is rising at **0814** and transiting at **1321** and setting by **1829**. See Jupiter for the Moon interference.
- **Uranus:** On the first Uranus rises at **1443**, transits at **2124** and sets by **0404+**. The apparent magnitude is 5.68 so we're on the ragged edge of being naked-eye visible. The Astronomer's Bane will be Full to the east so you may not be able to peek out a view. By the ides Uranus is rising at **2054** transiting at **2027** and setting by **0307+**. End of the month and the "sky god" is rising at **1243**, transiting at **1923** and setting by **0203+** while a Waning gibbous 95% illuminated Moon glares away 89° to the east.
- **Neptune:** Neptune is leading Mars and Uranus. Neptune is rising at **1233** in the beginning of the month, transiting at **1821**, setting by **0009+**. There is a Full Moon more than 100° eastward of Neptune. By the 15th Neptune is rising at **1138** and transiting at **1726** and setting at **2315**. By the end of the month Neptune is rising at **1036**, transiting at **1624** and setting by **2213**. The Moon is 137° eastward with 95% illumination.
- **Pluto:** On the first of the month Pluto is leading both Jupiter and Saturn. Pluto rises at **0945**, transiting by **1445** and sets at **1945**. By mid-month Pluto is rising by **0852**. Pluto transits at **1352** and sets at **1851**. By the 31st Pluto is transiting at **1251** and setting at **1751**. Too close to the sun though.

Asteroids:

- Still a dearth of asteroids. I searched for asteroids in 2020 with a reasonable magnitude; say less than or equal to +10 in December 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 9.3 – is the largest and most massive asteroid in the inner Solar System.

(16) Psyche Asteroid in Taurus 1st – 30th rising: mag 9.7 – Psyche is one of the ten most massive asteroids in the main belt, and is the most massive M-type asteroid.



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(8) Flora Asteroid in Cetus 1st – 30th rising: mag 9.2 – 8 – a large, bright main-belt asteroid.

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 believed 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

11P/Tempel-Swift-LINEAR

December 01 Mag: 9.2 Rises: 0126 Sets: 0234 comet in Pisces

December 15 Mag: 9.5 Rises: 0117 Sets: 0207 comet in Pisces

December 31 Mag: 9.9 Rises: 0103 Sets: 0144 comet in Cetus

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 December 2020 at 2100 PDT and you will have about 20 minutes of viewing time total.

- NGC 2264



*By NASA - NASA/JPL-Caltech/P.S. Teixeira
(Center for Astrophysics)*

NGC 2264 is the designation number of the New General Catalogue that identifies two astronomical objects as a single object: the Cone Nebula, and the Christmas Tree Cluster.



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Two other objects are within this designation but not officially included, the Snowflake Cluster, and the Fox Fur Nebula.

All of the objects are located in the Monoceros constellation and are located about 800 parsecs or 2,600 light-years from Earth.

NGC 2264 is sometimes referred to as the Christmas Tree Cluster and the Cone Nebula. However, the designation of NGC 2264 in the New General Catalogue refers to both objects and not the cluster alone.

NGC 2264 is the location where the Cone Nebula, the Stellar Snowflake Cluster and the Christmas Tree Cluster have formed in this emission nebula. For reference, the Stellar Snowflake Cluster is located 2,700 light years away in the constellation Monoceros. The Monoceros constellation is not typically visible by the naked eye due to its lack of colossal stars.

The Snowflake Cluster was granted its name due to its unmistakable pinwheel-like shape and its assortment of bright colors. The Christmas Tree star formation consists of young stars obscured by heavy layers of dust clouds. These dust clouds, along with hydrogen and helium are producing luminous new stars. The combination of dense clouds and an array of colors creates a color map filled with varying wavelengths. As seen in the photographs taken by the Spitzer Space telescope, we are able to differentiate between young red stars and older blue stars.

With varying youthful stars comes vast changes to the overall structure of the clusters and nebula. For a cluster to be considered a Snowflake, it must remain in the original location the star was formed.

When referring to this emission nebula overall, there are several aspects that contribute to the prominent configuration of a snowflake and/or Christmas tree cluster. There is a diverse arrangement of brilliant colors, and an evolving process of structure that follow star formation in a nebula. ([Wikipedia](#))

○ NGC 2023



By Ken Crawford, CC BY-SA 3.0

- NGC 2023 is an emission and reflection nebula in the equatorial constellation of Orion. It was discovered by the German-born astronomer William Herschel on 6 January 1785. This reflection nebula is one of the largest in the sky, with a size of 10×10 arcminutes. It is located at a distance of 1,300 ly (400 pc) from the Sun, and is positioned $\sim 15'$ to the northeast of the Horsehead Nebula. This star-forming nebula forms part of the Orion B molecular cloud, or Lynds 1630, and is located in the northern section of this complex. In terms of stellar density, it is the poorest of the four clusters embedded in the cloud complex, with only 21 embedded infrared sources. The reflection nebula is illuminated by the Herbig Ae/Be star HD 37903, which has a spectral class of about B2 Ve. The region around the central star is radiating fluorescent molecular hydrogen emission at a near-infrared range. Infrared emission of polycyclic aromatic hydrocarbons has been detected from the nebula's dust. ([Wikipedia](#))

December is great for both viewing and imaging. Spend some time outside with your scope. Autumn is waning and winter objects are here.

For now – Keep looking up.



Random Thoughts – Astro Humor

by Chuck Dyson

Before I get to the humor part of this random ramble, I want to say a few final words about eyepieces and then be done with the subject, for now.

Several weeks ago at one of our Friday night optical soirees at South Coast Winery I made a pest out of myself by having those present do a survey of mostly 20mm [Kellner eyepieces](#) with the goal of seeing, pun intended, if bargain basement eyepieces could compare at all with expensive eyepieces. The Kellner design was the first “modern” eyepiece design with a cemented doublet in the field position and a single lens in the eye position. I say mostly Kellner because two were not of a Kellner design. One eyepiece was a modern BSA flat field eyepiece with a 65° apparent field of view (AFOV) and the other was a [Huygenian](#) two element design with a 25° AFOV, this was the first multiple glass element design. The Kellners sporting a 45° field of view were a Takahashi sponsored eyepiece, an Edmund RKE (the RKE is a Kellner with the single lens in the field position and the doublet in the eye lens position), an Orion “free” Kellner that came with a low cost refractor, and a Surplus Shed bargain Kellner eyepiece (\$6.95). Of the eyepieces, the RKE and the BSA were fully multicoated. The Takahashi and the Orion were fully coated, one layer of anti-reflective coating on all surfaces. The Surplus Shed Kellner had a coating on the external surfaces of the field and eye lens only. The Huygens had no coatings on any surface. The scope was a Celestron six inch Schmidt-Cassegrain with a focal length of 1500mm, so the magnification of the target was 75X. Jupiter was the target for all eyepieces.

There was general agreement that all the Kellners gave a very reasonable view of Jupiter if a bit constricted when compared to the BSA 65° AFOV eyepiece. It would be good to remember that we were looking at Jupiter at 75X through an f/10 telescope and low power views in longer f/ratio telescopes are the recognized forte of the Kellner eyepiece. The big surprise was how closely the view through the Orion eyepiece matched the Takahashi eyepiece : both gave good images and showed clearly the major bands on Jupiter. The no name Kellner gave a view of Jupiter that was just a little fuzzy, no sharp lines here people.

The eyepiece that got the “OH MY!” comment from several viewers was the Edmund RKE. The view was sharp and crisp; however at it’s current price of \$85, it is no bargain find but rather you get what you pay for, in this case. Last and not least was the Huygens eyepiece. We need to give the Huygens a little slack as it was designed in 1684 but, that being said, the eyepiece is still a sound introduction to the challenging world of soda straw viewing, you were never going to cut your eye on sharp images, and the internal reflections provide for a wondrous light show around to object being viewed.

What are the takeaways, if any, from this little experiment? I think that there are four: First, any astronomer who has struggled with a Huygens eyepiece and is shown a Kellner will think that has been blessed with a miracle eyepiece. Second, even the eyepiece with only the field lens and eye lens outside surfaces coated showed remarkable control of internal reflections, optical coatings really work. Third, although the 65° field of view eyepiece gave the observer a wider



view of the sky the images of objects were no sharper than they were in the good quality Kellners. And finally, fourth: You are not a bad person if you do not bring your 10mm (\$628) and 21mm (\$845) Ethos eyepieces to a public outreach event. The public will be just as thrilled at the view of Jupiter through a Celestron Omni Plossl (\$29.95) and you will not have to worry about going home and cleaning potato chip grease enhanced fingerprints off of your Ethos eyepieces. OK I'm done.

The Humor Part

I thought that I would end the year with a lighthearted look at the sciences and hopefully we can have 2020 go out with just a bit of a chuckle.

The different sciences defined:
If it's green or wiggles, it's biology.
If it stinks, it's chemistry.
If it doesn't work, it's physics
If it has faults, it's geology.
If it is incomprehensible, it's mathematics.
If it doesn't make sense, it's either economics or psychology.

When we have visitors my wife puts a warning sign over my head:
WARNING: May Spontaneously Start Talking About Science Stuff.

You can't buy happiness; but you can buy a telescope and that's pretty much the same thing.

A day without Astronomy is like ----- Just kidding, I have no idea.

What do astronomers have in common with the paparazzi? They both take pictures of stars.
Because light travels faster than sound; people may appear bright until you hear them speak.

I like chemists better than astronomers. Because chemists say alcohol is a solution.

Astronomers have it easy in chemistry because their periodic table only has the elements Hydrogen and Helium with everything else just labeled metals.

Chemistry is just like cooking (just don't lick the spoon).

Um²⁹ is the element of confusion.

I was reading a book on Helium and I just could not put it down.

The human body is primarily composed of Carbon (C), Hydrogen (H), Oxygen (O), and a little bit of Sodium (Na) ----- So, we are 100% NaCHO --- See you at Taco Bell!



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“Remember; the only difference between screwing around and science is writing it down.”
[Adam Savage](#) of Myth Busters.

Research: [ri-surch]-Def. What you are doing when you don't know what you are doing.

I have trouble getting up in the morning because I obey Newton's first law:
A body at rest wants to stay at rest.

I am not lazy; I'm overflowing with potential energy.

Sign on a lab door:
Theory is when you know everything, but nothing works.
Practice is when everything works, but no one knows why.
In our lab, theory and practice are combined: nothing works, and no one knows why.

Sign on my lab door:
Do Not Trust Atoms
They Make Up Everything!

In 1905 Albert Einstein published a theory about space. And it was about time.

How does Einstein begin a story?
“Once upon a space-time”

Einstein also tells us that what happens in a black hole stays in a black hole.
Hawking, however, was not convinced of this.

The meaning of $E=MC^2$ explained. MILK X COFFEE²= ENERGY

You matter, unless you multiply yourself by the speed of light, then you energy.

Enough of Einstein and time for a few thoughts on our own solar system.

Why don't aliens visit our solar system? All of our reviews are just one star.

And God created Saturn. And he liked it; so, he put a ring on it.

One day on Mercury lasts about 1,408 hours. The same as one Monday on Earth.

What did Earth say to the other planets? You guys have no life!

The dinosaur wondered why the asteroid kept looking larger. Then it hit him.



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The following quips are the mandatory Uranus jokes where we all get to be 7 or 8 years old again, or you may skip these if you are body part sensitive.

The patient was offended when the doctor said "I like Pluto better than Uranus.

NEWS FLASH!

NASA to send a probe to URANUS
People everywhere giggle.

And this is how we teach kids in the science club about the eighth planet:

Uranus looks like a star
There are rings around Uranus
The wind from Uranus blows at 512 mph.
NASA has only explored Uranus once.
There are spots on Uranus
Uranus is tilted sideways.

I will end this month's column with a personal rant, because I can, and my personal favorite quip of all time; with nothing to do with astronomy but, I get such a visual from it.

The Rant

If a 747 can carry the Space Shuttle,
Then I call #%\$@*! on the overweight luggage fees charged to my telescopes!

My personal favorite:

Why am I the only naked person at this gender reveal party?

Have a great 2021

Cheers, Chuck



Visitors to Both Jupiter and Saturn

by David Prosper

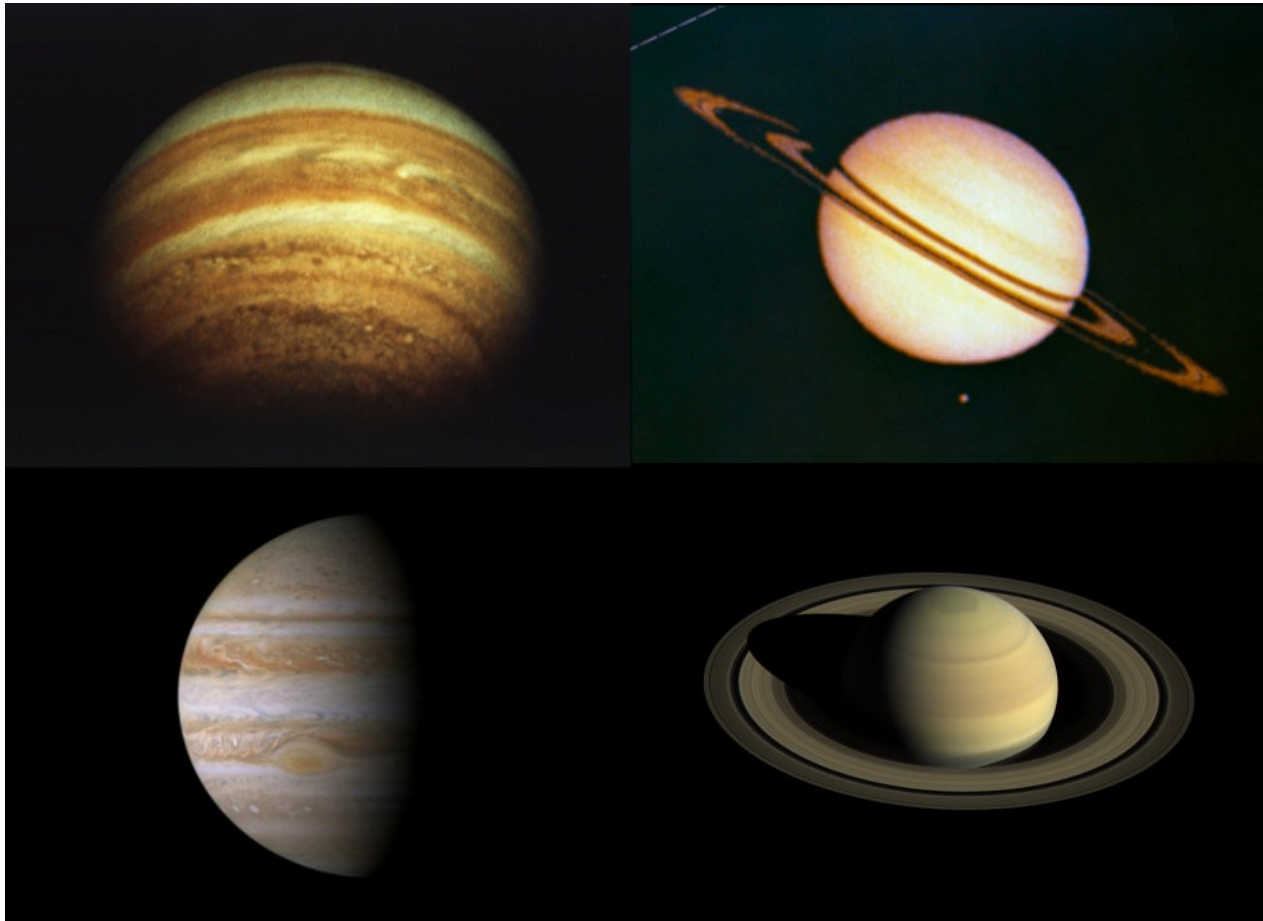
Have you observed Jupiter and Saturn moving closer to each other over the past few months? On December 21, the two worlds will be at their closest, around 1/5 of a full Moon apart! While the two gas giants may *appear* close, in reality they are hundreds of millions of miles apart. Despite this vast distance, a select few missions have visited both worlds by using a gravity assist from giant Jupiter to slingshot them towards Saturn, saving time and fuel.

Pioneer 11 was the first mission to visit both worlds! Launched in 1973, the probe flew past Jupiter in late 1974, passing just 26,612 miles above its stormy clouds. In 1979, it became the first spacecraft to encounter Saturn. Pioneer 11 took the first up-close photos of Saturn and its satellites, and made many exciting discoveries, including the detection of its magnetic field and a faint “F” ring, before departing Saturn and eventually, the solar system.

The Voyager missions quickly followed up, taking a “Grand Tour” of the four largest and most distant planets in our solar system. Both probes were launched within two weeks of each other in 1977. Voyager 1 flew past Jupiter in March 1979, discovering Jupiter’s faint ring and two new moons, along with active volcanoes on Io’s surface! The probe then flew past Saturn in November 1980, discovering five new moons, a new “G” ring, mysterious ring “spokes,” and “shepherd moons” shaping the rings. After a brief encounter with Titan revealed evidence of complex organic chemistry and liquid on the moon’s frigid surface, Voyager 1 was flung out of the plane of the solar system. Following close behind, Voyager 2 took detailed photos of Jupiter’s moons and cloud tops in July 1979. Flying past Saturn in August 1981, Voyager 2 measured the thickness of Saturn’s rings and took detailed photos of many of its moons. This second explorer then captured images of Uranus and Neptune before leaving our solar system.

Cassini-Huygens was the last mission to visit both worlds. Launched in 1997, the mission flew past Jupiter in late 2000 and took incredibly detailed photos of its stormy atmosphere and faint rings. Cassini entered into Saturn’s orbit on July 1, 2004. The Huygens probe separated from Cassini, landing on Titan to become the first probe in the outer solar system. Cassini discovered geysers on Enceladus, fine details in Saturn’s rings, many more moons and “moonlets,” the changing oceans of Titan, and seasonal changes on Saturn itself. After revolutionizing our understanding of the Saturnian system, Cassini’s mission ended with a fiery plunge into its atmosphere on September 15, 2017.

What’s next for the exploration of the outer worlds of our solar system? While Juno is currently in orbit around Jupiter, there are more missions in development to study the moons of Jupiter and Saturn. Discover more about future NASA missions to the outer worlds of our solar system at [nasa.gov](https://www.nasa.gov).



The difference in technology between generations of space probes can be stunning! The top two photos of Jupiter and Saturn were taken by Pioneer 11 in 1974 (Jupiter) and 1979 (Saturn); the bottom two were taken by Cassini in 2000 (Flyby of Jupiter) and 2016 (Saturn). What kinds of photos await us from future generations of deep space explorers?

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 <https://nightsky.jpl.nasa.org> to find local clubs, events, and more!





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The TVA is a member club of [The Astronomical League](#).

