SIRIUS ASTRONOMER

www.ocastronomers.org

The Newsletter of the Orange County Astronomers

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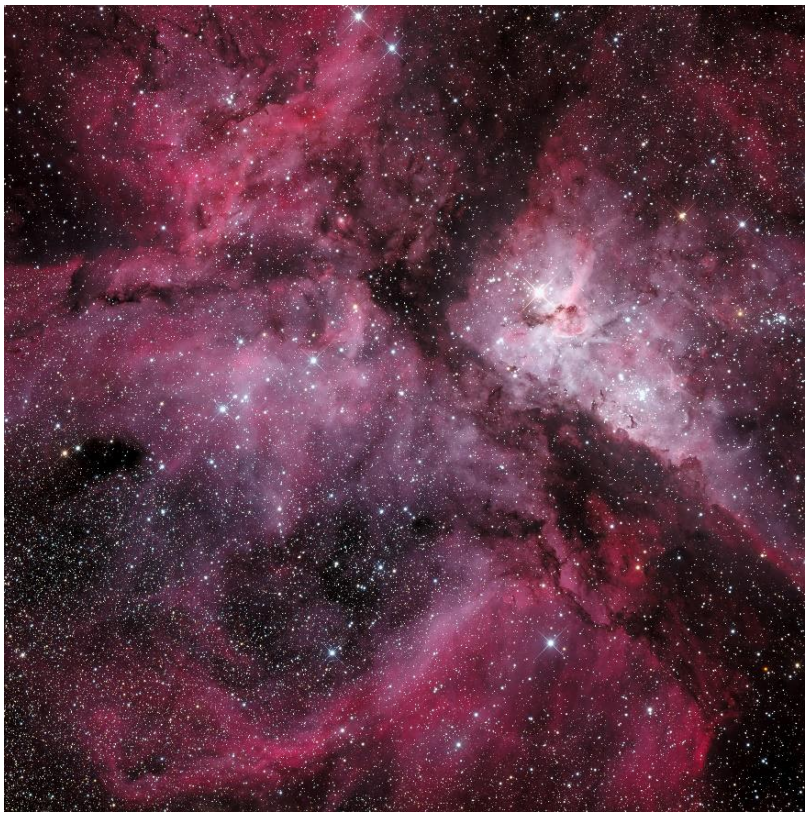


From Tom Bash we have the Eta Carina Nebula, imaged remotely from ChileScope 6/20/20 with an FLI 16803 camera on a 20 inch imaging Newtonian.

Because of the COVID-19 crisis and ongoing efforts to reduce exposure to the virus:

- **All in-person club events are cancelled**
- **Use of the Anza site is discouraged**

Please read more about how OC Astronomers has modified its activities on page 2.

Upcoming Events - free and open to the public

Beginner's class	Friday, 5 November at 7:30 to 9:30 PM ONLINE This is session 3 which covers different methods of finding objects in the night sky. This is presented by David Pearson. Class materials can be downloaded from OCA website.
Club Meeting	Friday, 12 November at 7:30 to 9:30 PM ONLINE "What's Up?": Chris Butler from OCA Main speaker: Alan Dyer whose talk will be "Chasing the Northern Lights"
Open Spiral Bar	Saturday, 13 November at 10:00 to 11:30 PM ONLINE Want to socialize? Grab your images, experiences, questions, or none and see your fellow Orange County Astronomers face-to-face.

Please consult the calendar on the OCA website to RSVP (required)

Response to COVID-19 Crisis

COVID-19 continues to affect all our activities. Some in-person club events remain cancelled while others are beginning to occur or are in the process of being scheduled. Cancellation periods for specific events are detailed below. Please see the President's Message for additional information.

Any use of the club's Anza site by members is at their own risk as we have no way of cleaning or sanitizing the site to CDC standards. If you must go to the site, be sure to clean and sanitize surfaces you have contact with and make sure it is cleaner when you leave than it was when you arrived. You must bring cleaning supplies and sanitizer with you as it is not provided at the site. Be sure to take any trash that you generate or find on the site out with you, and please maintain social distancing if anyone else is out there.

If you have any questions, feel free to contact board members or post them to the email groups or through social media. We will do our best to respond, but please bear with us if there is a delay as we all have other responsibilities as well.

We hope you and your families and friends all remain safe and healthy, and best wishes to all of you!

Summary of Cancellations of OCA In-Person Events

Due to the ongoing COVID-19 crisis, all in-person club events are cancelled through at least the following periods:

General Meetings	Cancelled until further notice; please try our virtual meetings instead.
Anza Star Parties	May start up again in January. Expect further updates on this.
Orange County Star Party	Cancelled until allowed by Orange County Parks, discussions are underway.
Outreaches	We are scheduling events starting in November.
Beginners Astronomy Class	Cancelled indefinitely, please contact Dave Pearson to attend Zoom classes.
SIG Meetings	Astrophysics SIG has resumed meeting in person. AstroImaging remains cancelled indefinitely, depending in part on availability of facilities and when meetings could go forward safely. Some may schedule Zoom events.

Please check the website, email groups and social media for updates.

From the Editor

Sirius wants photograph submissions from club members

Please send pictures to me along with a brief description of the subject, where the image was taken, and the equipment used.
For projects made, send an email with a brief description and the editor will work with you to produce an article.

Ideas for Future articles

The newsletter includes articles from members or about subjects suggested by our members. We seek ideas and writers to cover them. To contribute an article or work with the editor to produce one, please contact me at newsletter@ocastronomers.org .

Due dates for submission of articles, pictures and advertisements

Issue		Due date
December	>>	18 November
January	>>	22 December
February		22 January

President's Message

By Barbara Toy

Amazingly, the Holiday Season is quickly approaching and with it the end of 2021 – some of us hoped it would be an easier year than 2020, but I can't say that's how it worked out, and certainly things are far from the "normal" we were used to back in the early days of 2020. It seems a lifetime ago now, doesn't it?

Even though it hasn't been quite a year, sometimes Thanksgiving, 2020, seems a particularly distant lifetime away – that was the day when my husband and I both realized we had Covid, when we couldn't smell the roasting turkey. Fortunately, we were the only ones in our families to actually get the disease. As I've said before, I strongly recommend doing all you can to avoid it, even a mild case can have long-term effects. I'm still missing a lot of my sense of smell, but I hope it'll be back enough that I can smell the roasting turkey this year. And I'm totally looking forward to getting together with family to enjoy all that great food in good company, a big change from this time last year.

I hope all of you are able to have good Thanksgiving celebrations with family and friends as well. For those whose families have been sadly diminished by the disease, or who may have family or friends still battling Covid and its long-term effects, or suffering them yourself – I'm very sorry you and your loved ones are going through that, and I hope you find something to lighten your heart for a while in this period of the year that should be a season of hope.

On the Club Side of Things…

I'm happy to report that we really are starting in-person outreach events, and the first should have occurred by the time you see this. It's all with a lot of care, of course, to minimize risk to our volunteers as well as to those coming to do some viewing through the telescopes. Fortunately, the evidence seems to indicate that the virus doesn't transfer as much from contact with surfaces where it may have landed as originally feared, so sanitizing equipment between users should be less of a problem than we thought it would be a few months ago (not to be ignored, but extreme measure shouldn't be needed).

Along those with vaccinations, the most important measures to protect everyone concerned are still keeping social distancing and using masks. Ceci Caballero, our Outreach Coordinator through these particularly challenging times, has told us that schools are making plans to have other activities going on with the viewing to help keep students interested and occupied while they wait for their turn for viewing, and keeping actual groups sent to the viewing areas much smaller than at pre-Covid outreaches, to reduce the chance of exposure.

There's a lot of talk in general about "pent up demand" from all the restrictions during the pandemic, and we're certainly seeing that with schools, parks and others wanting to set up viewing events – Ceci has really been inundated and the calendar is filling fast. These events are great opportunities to introduce people to some of what can be seen up in the night sky even from bright city locations, so if you have some evenings you could spend on an event like that, please contact Ceci about volunteering for the program (outreach@ocastronomers.org).

On Volunteering…

Because we've had so many excellent volunteers over the years who have kept things running smoothly, people often forget that our club is totally run by volunteers – we've never had any employees. Fortunately, we have the resources these days to be able to hire professionals to take care of certain problems, like replacing the pump for the well at Anza a few years ago and replacing our original water tank as well, but almost all of our infrastructure at our Anza site was built by volunteers and the ongoing maintenance at the site is by the continuing work of volunteers. "Infrastructure" includes building the club observatory, building and installing the Kuhn telescope (designed and built by Bill Kuhn), digging the trenches and laying the pipe for the water lines, installing the septic tanks, getting Anza House up and running, putting in roads, stairs, observing pads, etc. – if you can get some of the "old-timers" (not old so much as having been around the club a long time) talking about those days, you can hear some amazing stories.

Our general meetings, Special Interest Groups and other activities are planned and run by volunteers, and, of course, the trustees and officers on our governing Board are all volunteers as well. And for many of us, the entry point for all this was the Outreach program.

When I was a new member, I remember Jim Benet, our Outreach Coordinator at the time, making a pitch at one of the general meetings about needing volunteers in terms that somehow appealed to me enough that I diffidently approached him about whether my newly acquired ETX-90 would be adequate for doing outreach (I was even more diffident about my knowledge of the night sky for good reason – at the time I think I could reliably identify the sun, the moon, the Pleaides, the Big Dipper and Orion, but beyond that things were pretty sketchy, and this was in pre-GoTo times).

Jim assured me that the telescope would be great for outreach, and I somehow was quickly signed up for an event that turned out not to be that great as an outreach event per se (the location was too bright to see much) but was totally great as a way to get to know my fellow volunteers, who were wonderfully informative as well as fun to talk to. So I went to more outreaches, and discovered what a blast it was to show off my few little paltry objects to people who, incredibly, knew even less than I did about the night sky. And I quickly learned about other objects from other volunteers, and more background on them that I could share with people viewing them. I don't know how much the viewers got out of our program but I got a tremendous amount out of it personally and got to know some pretty incredible people, not least of them Jim Benet himself.

It was Jim who suggested that I should run for a trustee position on the Board, which I don't think would have occurred to me without him pushing the idea. Being on the Board has been as much fun in its own way as doing outreach. And it turns out that a lot of people who have been on the Board over the years have been frequent volunteers in the outreach program, as have volunteers in other areas. Unfortunately for me, between my current job and family concerns, my evenings haven't been available the way they were in my early years in the club and I had to give that up, but have never forgotten the pleasures of those evenings.

While this may possibly seem like a cautionary tale of slippery slopes leading to dire consequences, it's actually a tale of rewards beyond this new member's wildest dreams on joining. Most of us join because we want safe viewing locations with good company, or are interested in learning more about astronomy or want to benefit from the club's various other activities. Those are great reasons to join, but what I found when I started showing up for outreaches was that there was a whole different level of the club that I hadn't suspected, which I could become part of just by volunteering. That has given me much richer and more interesting experiences and taught me a lot more than I ever expected when I joined.

You can get to know some fellow members at club meetings or star parties, but I find you get to know more of them better and faster when you're all working together to make particular events or activities successful. When you run into those people at other events or places like our email groups, there's a different sense of recognition as well as more to share and talk about. If you want to know more people in the club or to feel more involved, the easiest way is to grab any volunteer opportunity that comes up. And the more you participate that way, the more those opportunities tend to come up…

Along with outreaches, we have another great volunteer opportunity right now with our annual election – getting involved in governing the club is a truly enriching experience. We're still taking nominations through the end of the November General Meeting, so email Alan Smallbone if you want to be put on the ballot (asmallbone@earthlink.net).

And, seriously, if you've never volunteered for anything – give it a try. Like others, you may discover a whole new wonderful world of fun you can't experience any other way.

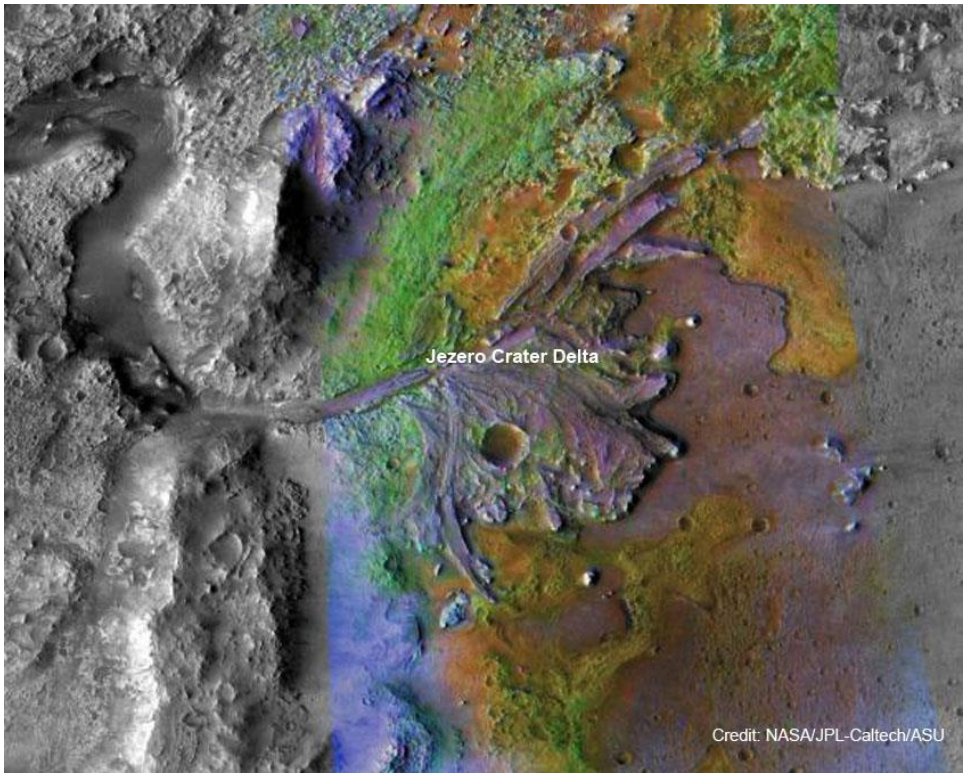
AstroSpace Update

November 2021
Astronomy and space news summarized by Don Lynn from NASA and other sources

Mars Helicopter – Since the Mars helicopter Ingenuity made its first flights, the air pressure at its site has dropped by roughly 1/3. This is a normal Martian seasonal occurrence, due to the large amount of carbon dioxide that freezes out of the atmosphere into the seasonal polar caps. Helicopter controllers had not planned on still making flights as the Martian season changes, so the expected pressure drop wasn't going to matter. But the helicopter mission was extended, so a plan was made to fly at reduced pressure by spinning the rotors faster. In mid-September a test was run to see if the rotors would spin faster, and the test was successful. The rotor blade tips reached nearly 80% the Martian speed of sound. However, 2 further test flights attempting to lift off at higher spin did not actually lift off. Then Mars went behind the Sun, interrupting communication with all craft on Mars. Meanwhile controllers are working on determining what went wrong. Stay tuned.

Marsquakes – The InSight Mars lander has detected 3 more large marsquakes. Before Mars in its highly elliptical orbit reached its farthest from the Sun, spacecraft controllers were planning to turn off the seismometer during the period of weakest sunlight and therefore lowest solar panel electrical generation. However, an experiment to see if controllers could clean dust off the solar panels by trickling blowing sand on them was successful and sufficient power was generated to leave the seismometer on. Otherwise, these latest large marsquakes would have been missed. Two quakes occurred in the daytime. The 3 quakes occurred at different distances from InSight. All previous large marsquakes had occurred at one location, the area called Cerberus Fossae.

Mars Floods – The Mars rover Perseverance has been studying the western delta fan, which was built up by layers of sediment dropped into Jezero Crater by a river back when the crater was a lake, about 3.7 billion years ago. The fan contains about 2 dozen large boulders and hundreds of smaller stones that had to have been carried here by powerful floods, not by gently flowing water. These rocks are believed to have been carried here from tens of miles away. Based on the position of the boulders relative to calmly layered areas, scientists believe that the violent floods occurred late in the history of the lake in Jezero. It is not known if the floods moving the boulders were caused by heavy rains or massive snow melts or other origin. Further study is needed and is expected to be provided when the rover approaches this area more closely.



Galaxies Without New Stars – Scientists have discovered 6 very distant large galaxies that had already stopped forming new stars just a few billion years after the Big Bang. Most other galaxies at this time were peaking in their production of new stars. The 6 galaxies were discovered in images taken by the Hubble Space Telescope to look at very distant objects through gravitational lenses, in which gravity of a galaxy cluster bends light, magnifying and brightening objects behind. Follow-up observations of the 6 galaxies were made with ALMA, a radiotelescope array in Chile. Galaxies form new stars when there is adequate cool gas to collapse into stars. It is not known whether these 6 galaxies had their gas heated somehow, or expelled their gas, or had turned all their gas into stars already. Further work needs to be done to distinguish which of these occurred.

Quasar Mass – A new method to find the mass of a quasar, which is being called spectroastrometry, has been developed. It can be performed using only a spectrum of the quasar. It determines the rotational speed of gas orbiting the black hole in the quasar, and it determines the distance at which that gas is orbiting, even when that distance appears too small to resolve with existing telescopes. The mass of the black hole is then calculated from the orbital size and speed of the orbiting material. The method was tested on the quasar J2123-0050 in Aquarius. It is so distant that its light left 2.9 billion years after the Big Bang.

Neutron Star Mass – It has been puzzling astronomers why the average mass of neutron stars detected by LIGO, the gravitational wave detectors, is considerably higher than the average mass of neutron stars seen with light (including radio and other forms of light). In fact, the masses of neutron stars seen almost never are as large as the masses seen by LIGO. A new study using computer simulations of supernova explosions appears to have solved this puzzle. When stars finish nuclear fusion of the hydrogen at their cores, it leaves a sphere of hydrogen, too cool to further fuse, surrounding the helium core, except: if the star is in a close orbit about a companion star, that companion gravitationally strips the hydrogen, leaving only the helium core. The new study found that when such a stripped helium core explodes as a supernova, it will leave behind either a neutron star that is more massive than usual, or a black hole that is less massive than usual. But this fully explains the puzzle only if there is some reason that these massive neutron stars created by helium core supernovas are almost never seen in light. Most neutrons stars seen in light are pulsars, that is, neutron stars that spin fast and give off radio or other forms of light, so that we see a pulse every time the emitting region rotates by. The simulations in the new study showed that the massive neutron stars produced by the helium core supernovas, depending on the masses of both the companion stars, can have very slow spin, and so likely will not be pulsars. Puzzle solved.

Best Observed Supernova – Astronomers using the Hubble Space Telescope and several other telescopes have obtained the best ever picture of how a massive star explodes as a supernova when it runs out of nuclear fuel. This one, known as SN 2020fqv, was first spotted by the Zwicky survey, which uses the large Schmidt camera at Palomar. It was immediately observed with Hubble, which was able to analyze the material closely surrounding the star, before the explosion had blown away this material, which was determined to have been expelled over the year preceding the explosion. Archived Hubble images were found that recorded the star's behavior for decades prior to the explosion. The star was found to be in the current field of view of TESS, a planet-finding space telescope. TESS takes an image of its current field every 30 minutes, so a detailed record of the star's brightness change was obtained, both before and after the explosion. The mass of the star before exploding was calculated by 3 different methods, which agreed well, at 14 to 15 times the Sun's mass. The mass of a star that explodes is important to know because stars of different mass explode differently. Astronomers are examining the behavior of the star in the decades before it exploded in hopes of being able to predict when other massive stars are going to explode. The supernova is located in the colliding Butterfly galaxies, NGC 4567 and 4568, in Virgo.

White Dwarfs – A new survey was made that observed every known white dwarf star within 65 light-years of us, using both spectra and polarization. Previous studies of white dwarfs have observed only the brighter ones, so likely produced biased views of white dwarfs. In particular, white dwarfs cool as they age, producing dimmer light, so previous observations have tended to neglect older white dwarfs. New findings about white dwarfs include: weak magnetic fields are quite common; magnetic fields at the surface of the stars are rare in young white dwarfs, but typically develop later as the star cools, and increase with age. About 2/3 of the stars in this study had never been observed in spectra and polarization before.

FRB – The giant Chinese radiotelescope dish FAST in 2019 observed the location where a fast radio burst (FRB) was first seen in 2012, and has been seen to repeat bursts since. The FAST observations saw 1652 more bursts. This is more bursts than all other FRBs ever observed. The cause of FRBs is still a mystery, and among the proposed causes are highly magnetic neutron stars, black holes, and cosmic strings. Periods between 1 millisecond and 1000 seconds were searched for in the new observations, but no period was found. Most FRBs have never been seen to repeat, but a few repeaters are known, of which the one observed by FAST was the first discovered.

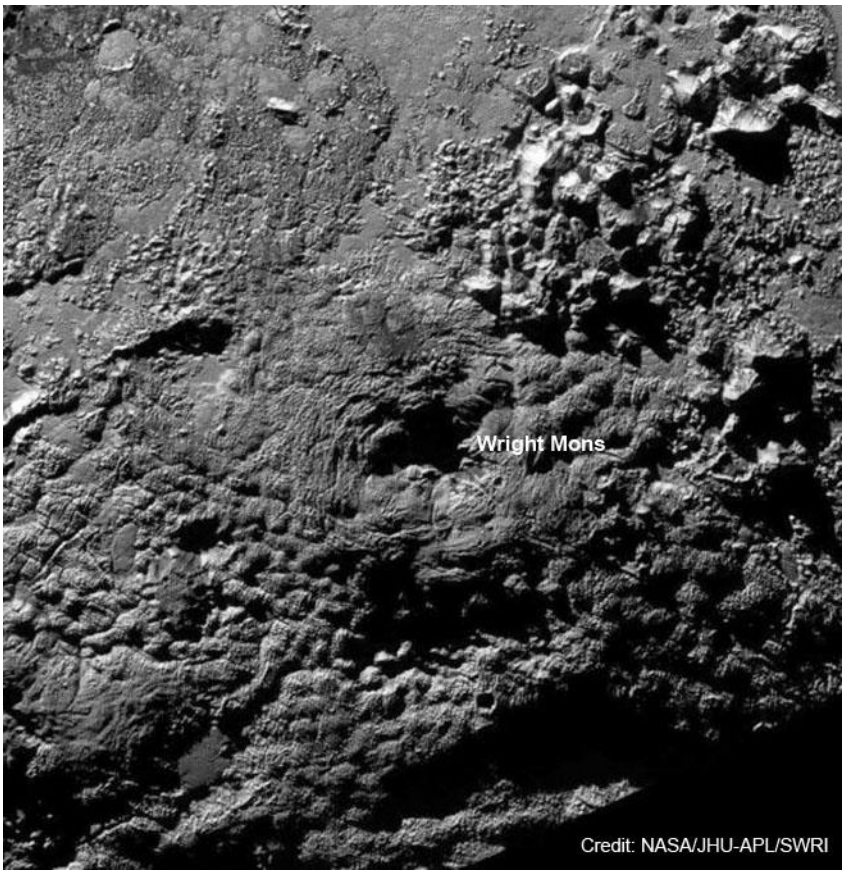
Active Asteroid – Comets have elongated orbits at random tilts compared to planet orbits and, when near the Sun, give of material that forms a head and tail. Asteroids do not give off material and tend to have more circular, less inclined orbits. Then there are about 20 objects with comet/asteroid identity crises, being termed active asteroids. Another of these has been discovered, called asteroid 248370. It orbits in the low-tilt, nearly circular asteroid belt beyond Mars's orbit. But in July it was seen to be giving off gas and forming a tail when it neared its closest point to the Sun (perihelion). The tail is particularly narrow, which implies that the material being thrown off is doing so at very slow speeds. The comet-like activity was first spotted by the near-Earth object survey ATLAS, and confirmed by other telescopes. The next perihelion of this active asteroid will occur in September 2026, and astronomers are planning to be watching.

Another Active Asteroid – Phaethon is another one of those very few active asteroids, and is the only asteroid known to supply the material for a meteor shower; all meteor showers other than the Geminids come from comets. The meteor material is expelled from comets when they come close to the Sun in their orbits, warming up and sublimating ices (water ice, dry ice, etc.) into gas, which blows dust and pebbles off into space. A new study using simulation of asteroid behavior as it approaches the Sun may have solved how Phaethon produces meteors without having ices to sublimate. Apparently sodium takes the place of ices. Phaethon gets hot enough when near the Sun to boil sodium, which then blows off dust and pebbles. A lab test of a meteorite containing sodium heated to Phaethon's highest temperature confirmed this.

Taurid Objects – The Taurid meteors have long been known to be pieces sloughed off from Comet Encke. A few asteroids are known to orbit within that meteor stream, which has prompted some astronomers to believe that the comet and those asteroids are all broken pieces of a former larger body. The asteroids are too large to have come from Encke, so it had to be from a larger body. The breakup must have occurred about 20,000 years ago to match the current spread of objects. A new study found more objects with orbits similar to Encke, bringing the total to 88 objects. Cometary activity was found in 2/3 of the newly discovered objects. This is highly supportive of the theory of a bigger object breaking up. Previous work has proposed that collisions with objects in the Taurid cloud explain various die outs and other disasters.

Binary Trans-Neptunian Objects – New Horizons, the spacecraft that flew by Pluto in 2015, took images of a few small trans-Neptunian objects in its vicinity in 2018. New analysis of these images shows that 2 objects are each binaries, that is, 2 objects orbiting each other. The images showed the objects as elongated though they were not quite resolved as separate objects. However the brightness and shape matched computer simulations of binary objects nearly resolved. The best match for the object dubbed 2011 JY_{31} was two 30 mile wide components orbiting about 120 miles apart, while that for 2014 OS_{393} was two 19 mile components at about 90 miles separation.

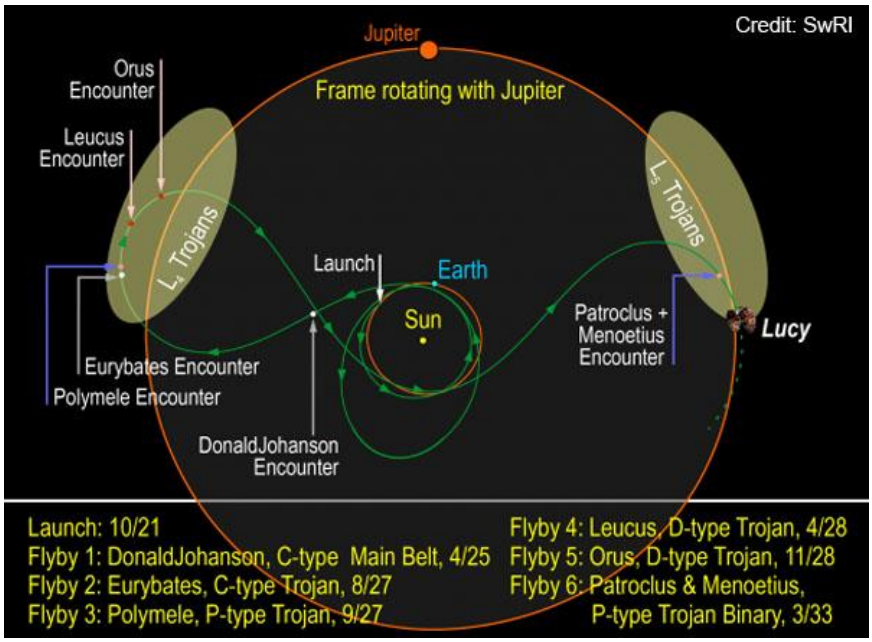
Plutonian Non Volcano – New analysis of images of Pluto taken by the New Horizons spacecraft show that the mountains named Wright Mons and Piccard Mons are likely not cryovolcanoes, in contradiction to earlier reports. Examining the elevations of the parts of the mountains showed they did not fit volcano shapes. The terrain about the mountains is likely frozen cryovolcanic material, but it appears that it did not erupt from either mountain, but probably erupted from openings elsewhere. By impact crater count, the area's age can be estimated at about 1 billion years. This raises the question of what heat source would exist that would drive cryovolcanic activity that late in Pluto's history. Changing tidal pulls can be ruled out because both Pluto and its large moon Charon have one face gravitationally locked to the direction of the other body, eliminating changes in tidal forces.



White Dwarf's Exoplanet – A Jupiter-mass exoplanet with a Jupiter-like orbit has been discovered orbiting a white dwarf star. Because white dwarfs have already passed through their giant phase, this is another piece of evidence that planets can survive the giant stage. This exoplanet was discovered using an unusual method: it showed up in a gravitational microlensing event, where a star passes in front of the exoplanet and the star's gravity bends the light of the background object, brightening it. This is the first discovery of a planet orbiting a white dwarf that was made using microlensing. The system was confirmed in infrared by the Keck-II telescope in Hawaii. While there is plenty of evidence of rocky planet debris orbiting white dwarfs, there are few intact planets doing so. It has been proposed that planets widely orbiting white dwarfs are common, so that they were outside the reach of the stars' giant phases, but they are just hard to detect.

Exoplanet Clouds – A team of astronomers has detected clouds in the atmosphere of an exoplanet named WASP-127b and also determined the altitude of those clouds. The work used both visible light (from a ground-based telescope) and infrared observations (from space) since those different wavelengths penetrate different depths of the planet's atmosphere. The measurements were made spectroscopically while the planet was passing in front of its star, allowing starlight to pass through the planet's atmosphere. Sodium and water vapor layers were found, with clouds of unknown constitution above that. The planet is a "hot Saturn", that is, it is roughly the mass of Saturn, but orbits so close to its star that it's temperature reaches over 1900°F. This puffs up the atmosphere to 1.3 times the size of Jupiter, making it one of the least dense planets known.

Exoplanet Auroras – Scientists using the LOFAR radiotelescope array discovered radio signals from 19 red dwarf stars which may be generated by auroras associated with unseen exoplanets. Further observations planned will search for periodic behavior in the radio signals and for more evidence of the planets using optical telescopes. LOFAR operates at lower radio frequencies than other radiotelescopes. Pieces of LOFAR are spread across Europe.



Lucy Launches – On October 16, the Lucy spacecraft launched to begin a 12-year mission to explore Trojan asteroids for the first time. Those asteroids share Jupiter's orbit, occupying the gravitationally stable Lagrange points that lie ahead and behind the giant planet. They are called Trojans because they are individually named after heroes of the mythological or perhaps historic war between Greece and Troy. Two flybys of Earth are planned, in 2022 and 2024, for gravity slingshots to move the spacecraft orbit out to the outer Solar System. The spacecraft sports two huge circular solar panels for power because it will reach the farthest distance ever from the Sun of any solar powered craft. Lucy was named after the 3 million year old fossil of a human ancestor found in east Africa in 1974 by Donald Johanson. It is hoped that the spacecraft will fill in a huge gap in Solar System history like the fossil filled for pre-human history. Astronomers believe that the Trojan asteroids have been relatively undisturbed since they formed at the same time as the Solar System planets and are likely made of the same material that formed the cores of the giant planets. Lucy the fossil was named after the Beatles song "Lucy in the Sky With Diamonds". Lucy the spacecraft does indeed have a diamond in the sky, as a component of an optical instrument. A plaque on the side of the spacecraft has inspirational quotes from Einstein, Sagan, several poet laureates, and the Beatles. On the way to the Trojans, the spacecraft will fly by a main-belt asteroid, which has fittingly been named DonaldJohanson. Seven Trojans will be visited, split among the leading and trailing Lagrange zones.

Lunar Rover Landing Site – NASA is planning to land a rover named VIPER on the Moon in 2023 to explore for near-surface ice and other resources. They just announced that a landing site has been selected: near the western edge of Nobile Crater in the south polar area. There is considerable evidence that there is ice in the Moon's polar areas. The selected landing site has areas of permanent shadow and sunny areas. The shadow areas are most likely to have preserved ice, but the sunny areas are needed to recharge the rover's batteries using solar panels. VIPER is part of the Artemis program to land people on the Moon.

Asteroid Mission – The University of Colorado at Boulder has made an agreement to build a spacecraft for the United Arab Emirates that will fly by 6 asteroids, and land on a seventh, to launch in 2028. The same parties built the Hope spacecraft that is now orbiting Mars.

Space Tourists – Blue Origin launched its second New Shepard rocket with crew to suborbital space. Aboard was William Shatner, the actor who played Captain Kirk, exploring the galaxy on Star Trek television and films. At age 90, he is the oldest person to reach space. Three other space tourists were on board, including a vice president of Blue Origin.

Space Movie – Russian actress Yulia Peresild and movie producer Klim Shipenko rode to the International Space Station aboard a Soyuz rocket to film the space-location parts of a movie called "Challenge" during a 12-day stay in space. Some cosmonauts also participated. The plot involves a surgeon who operates and saves the life of a cosmonaut in space. This is the first entertainment film, as opposed to documentaries, to be shot in space.

JAMES WEBB SPACE TELESCOPE - The Who, What, Where, When and Why

By Gene Kent

Part 2 continued from previous issue

MECHANICS

Sun shields:

The telescope, the cameras and spectrographs sit atop five layers of Kapton about the size of a tennis court. Kapton is a polyimide impervious to deterioration in extreme temperature ranges. The first layer of Kapton is about 53 µm thick. The next four layers are about 25 µm thick. The sun exposed side of the shield will maintain a temperature just under boiling, 85° C, while the shielded side temperature will be about -236°C, the temperature of unaffected space. As cold as unaffected space may seem, the MIRI needs near absolute zero to function. To that end, the JWST will carry with it a cryocooler which will drop the IR camera receptor temperature to -266° C which is barely 7° K, or just 7 degrees above absolute zero.

Radio:

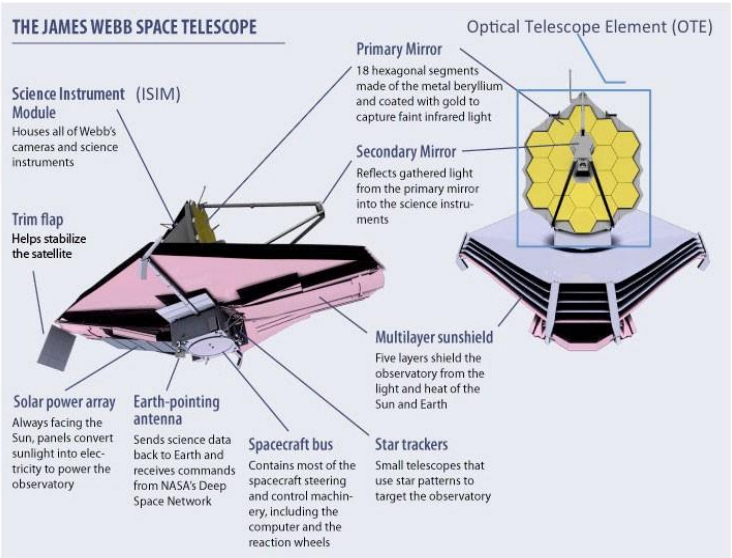
On the underside of the JWST are the engineering and electronics. These include the Earth-directed radio antenna which provides for the transmission of the images and spectrograms from the JWST to the anxious astronomers and scientists and the means of directing the JWST where to look next, with which instrument and for how long.

Attitude Control:

In the spacecraft bus are 6 gyros which unlike the Hubble gyros, have no moving parts. They are hemispherical resonator gyroscopes (HRG), more commonly known as *wine glass gyros*. They have a quartz hemisphere that vibrates at its resonant frequency in a vacuum. Electrodes detect changes in that vibration if the spacecraft moves even a tiny bit. The term wine glass comes from the wine glass bowl shape of the resonator and the harmonic resonance of a wine glass not unlike that of the HRG. Tap a wine glass and the resonance is obvious. These gyros have a predicted life of 10 million hours. A minimum of two gyros are required to maintain position. The four extras can be switched in to replace failing units. Learning from the gyro failures which limited the useful lifespan of the Hubble Space Telescope, the JWST engineers designed in greater redundancy.

The gyros hold the JWST attitude with very little variance; but, to move the spacecraft, reactions wheels are needed. Parliament passed Newton's third law of physics about 1687. It has received general adherence by all spacecraft builders. The law states *that for every action there is an equal and opposite reaction (are you still reading?)* The JWST has six reaction wheels – one and a spare for each attitude. For movement, a reaction wheel is spun and the JWST moves in the opposite direction. The gyros and reaction wheels are expected to bring the JWST within one minute of the target. The Fine Guidance System is expected to refine the accuracy down to 0.10".

To keep on target, the JWST is constantly "tacking" into the sun's waves. With a sail about the size of a tennis court (the size of the solar shields), this is no small matter. To aid in keeping station, the solar trim flap is meant to leverage itself against the sun's waves as a trim tab does on a plane or a sailboat. In addition, the JWST has 16 thrusters, large and small, to aid in positioning. The ability to position the telescope and the solar panels is the primary determinant for its life expectancy. The designed lifetime is 5 to 10 years. The electricity from the solar panels to the reaction wheels is inexhaustible. They can last as long as the bearing hold out. But the fuel for the thrusters is limited and once used, it is gone forever.

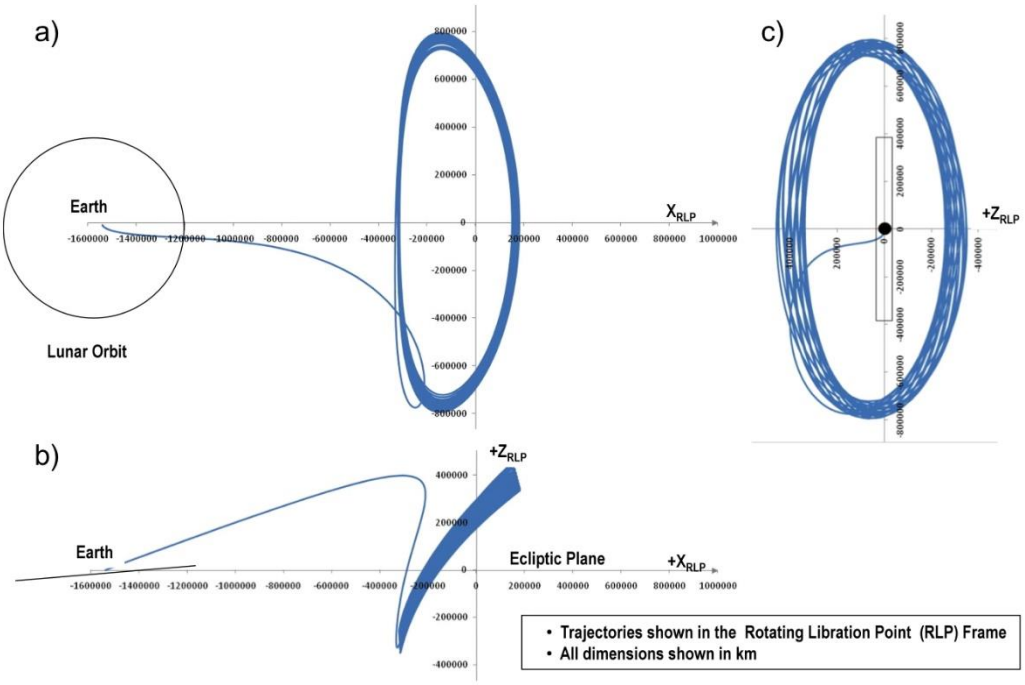


Where is the James Webb Space Telescope?

This folded up telescope is to be placed in a French Ariane V rocket and launched from French Guiana to gain the 1,000 mph sling of the earth's rotation at the equator. It will take the JWST about 29 days to travel the 950,000 miles from earth to the LaGrange 2 location. This is a spot in line with the earth and sun. The "spot" is not a spot at all, but an orbital trail somewhat perpendicular to the orbital plane of the earth around the sun. The JWST will be following the earth in in orbit around the sun, albeit 950,000 miles outside the earth's orbit while in a 600,000 mile diameter orbit of its own perpendicular to the plane of the earth's orbit. The JWST perpendicular orbit has no central nodule of gravitational pull to swing around, but is held in the orbit by the gravitational pull of the sun, the earth and our moon. It is referred to as a halo orbit. It will have taken about 30 days for the JWST to reach its insertion into its halo orbit. During this travel time, the JWST will unfold, start drawing power from the sun, spread its solar shield, exhaust any humidity that could freeze and lock in ice any moving parts and utilize it Fine Guidance Sensor to make any necessary mid-course corrections.

The halo orbit itself is not stable. Once initiated, it will require constant monitoring and periodic corrections about three times a year via the JWST's thrusters. The reaction wheels will be constantly at work to maintain attitude; but, the solar winds blowing against the tennis court size solar shields will be more than the reaction wheels can overcome without thruster help.

It seems the French had difficulty keeping their satellites in orbit in the early 1800's so they contacted the noted mathematician Joseph Louis LaGrange whose detailed study showed areas of orbital stability now referred to as LaGrange 1 through 5. (An almost true story)



When will the JWST be launched and see its first light ?

The intended launch of September 2021 has been delayed due to problems with the launch vehicle, the Ariane V. rocket. There was excessive vibration when the nose cone faring of the Ariane V rocket opened to release its cargo on its last two missions. ArianeSpace, the rocket builder has indicated it has fixed the problem. NASA intends to watch the next two Ariane V launches. If all goes well, the JWST could be launched in early 2022. The flight time from French Guiana to the L2 halo insertion will take just under 30 days. During that flight, the sun shield will be deployed, as will the primary and secondary mirrors. Solar panels will start producing electricity and directed radio antenna will pop out. Only so much can be done before insertion into the halo orbit. Once in orbit, it is anticipated that nearly a year of testing, calibration, and remote adjustments will be needed before begins its science work.

Why do we do it?

There have been a million good things come from pure science but few were actually anticipated. Richard Fineman said it best. "Physics is like sex. Sometimes something positive develops, but that is not why we do it."

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For Sale contact David Hobbs david_hobbs714@yahoo.com

- 20" F5 Research grade early Coulter mirror and secondary mirror $2800
- Primary mirror is 2 ¾" thick, Secondary is 4" x 5 5/8"

For Sale contact Ron Choi rongrace2@cox.net

- Orion StarShoot AutoGuider further reduced price $ 200

For Sale contact Jerry L Floyd jlfloyd720@gmail.com 562-252-5666

- ZWO Electronic Filter Wheel, 7x36mm $ 850
- Includes set of ZWO brand 36mm LRGB, S2, H-Alpha, O3 narrowband (7 nm) filters

This item was originally purchased in May 2020. It has been used a few times (with a ZWO ASI1600MM camera) but is in virtually new condition. I am selling it because I replaced it with a filter wheel that accommodates my 7 1.25" Astrodon filters.

The cost of the items as purchased new from a vendor such as OPT would be $299 for the filter wheel, $199 for the LRGB filter set, and $479 for the SHO filter set, a total of $977.

I am willing to deliver in person to the OCA Anza site or other Southern California locations.

For Sale contact Stephen Lauro colormaker13@gmail.com 1-714-393-5467 cell

- Meade LS-8 in excellent condition $ 2100
- AutoStar 3 handbox controller
- Upgraded Stellarvue 7x50 finder scope
- Meade electronic micro-focuser
- Has the most recent firmware: version 1.6e

I am asking $2100 but will accept a reasonable offer.

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