OKLAHOMA SPACE ALLIANCE

OUTREACH -March 2022

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet at the
McMurray residence at 2:00 p.m.
on March 12, details inside

Apollo 16 Commander John Young jumping in front of Lunar Rover and LEM (NASA Archives, taken by Charles Duke)

OKLAHOMA SPACE ALLIANCE OUTREACH
March 2022

March Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, March 12, at the McMurray's house. Prospective members are welcome. Their house is at 2715 Aspen Circle in Norman. To get to the meeting either: (1) Take the Lindsey Street east exit from I-35, turn right at Berry, and proceed to Imhoff Road. Turn right at Imhoff, right at Poplar Lane, left at Aspen Lane, and right at Aspen Circle. or (2) Take the Highway 9 east off I-35, turn left at Imhoff Road, left at Poplar, left at Aspen Lane, and right at Aspen Circle.

We will try to have this meeting on Zoom for those who cannot attend in person: To join the meeting, go to https://tinyurl.com/y2qtab28If for some reason the link doesn't work, call Clifford McMurray, Vice- President 405-329-4326 (H) 405-863-6173 (C) (e-mail cliffmcmurray at hotmail.com) , or Syd Henderson at 365-8983 (e-mail sydh at ou.edu) and we will send you updated information.

Saturday March 12, 2022, 2:00 p.m. (tentative)

1. Introductions and review of Space events this past month
2. What's Happening in Space, News, Pictures, and Videos approximately one hour. See http://osa.nss.org before the meeting for items to be discussed. (The impact of the Russian invasion of Ukraine on space will undoubtedly be part of it.)
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
   a. Review OSA treasurer's report
   b. Minutes of February meeting
   c. Chapters Assembly (Syd)
5. Video (to be announced)
6. Chat

Minutes of February 2022 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met February 12, 2022, at the McMurray's house in Norman, Oklahoma. Attending in person were Clifford and Claire McMurray. Tim Scott, Dave Sheely, and Syd Henderson. Russ Davoren attended by Zoom. OSA President Clifford McMurray presided over the meeting. He did an Update discussing links to material covered in the meeting and this is online at http://osa.nss.org/Update2202.pdf so I'll cover the details that aren't covered there.

We are losing our ability to see Near-Earth Asteroids at dawn or sunset due to satellite constellations. This is wanted to be able to see an asteroid on a collision course.

One proposed new launch system uses a sled to achieve speed so it can launch. As far as we know, no spacecraft has ever been launched in this way.

We read a Wired,com article on Stratolaunch, which may be back from the dead.

We watched a video on Rocket Lab's Neutron rocket, "Neutron the Next Generation Rocket." It stands forty meters high and is seven meters in diameter. It uses the Archimedes engine. Aim is for 24-hour turnaround.

We watched a United Arab Emirates video on their Mars mission which is studying Mars's aurora (!). [If I remember, Mars doesn't have a full-fledged planetary magnetic field, but does have magnetic patches.]

Heinz is coming out with a Marz Ketchup, which uses tomatoes grown in simulated Mars conditions, or simulated Martian tomatoes, or something other peripherally to do with Mars. Maybe. Makes me wonder why I haven't seen Mars bars lately. Maybe they're dissolving them into Ketchup.

We watched several episodes of "This Week in Space," Including a Viper Moon Lander test.

GOES-West photographed the cataclysmic volcanic eruption in Tonga.

Hubble has passed its billion second anniversary.

Russ mentioned that Fox (I assume the entertainment network) has a show called Xploration Station on Saturday morning. I'm looking for a showing.

We currently have $958.96 in checking and $257 in cash for a total of $1215.92.

Minutes by OSA Secretary Syd Henderson

Minutes of January 2022 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met January 8, 2022, at the McMurray's house in Norman, Oklahoma. Attending in person were Adam Hemphill, Clifford and Claire McMurray. John Northcutt, Tim Scott, Dave Sheely, and Syd Henderson. Robin Scott attended by Zoom. OSA President Clifford McMurray presided over the meeting. He did an Update discussing links to material covered in the meeting and this is online at http://osa.nss.org/Update2201.pdf so I'll cover the details that aren't covered there.

The Blue Origin New Shepard flight on December 11 was the first New Shepard spaceflight to carry a full complement of six, and the first to carry a parent and child (Lane and Cameron Bess), as well an carrying Alan Shepard's daughter Laura Shepard Churchley. We watched a video of the flight as well as a view of the astronauts floating inside the capsule.

We watched the launch of the kamikaze spacecraft DART, which will crash into the moonlet asteroid Dimorphos that orbits Didymos.

The top twenty collision hazards are Russian upper stages.

To date 609 people have flown in space. I don't know if this includes the Virgin Galactic flights.

We watched a video of the Tiangong space station second crew, including a video of Wang Yaping's spacewalk. We also watched a video of Yusaka Maezawa, the space tourist on the ISS, who was doing a presentation for the home crowd on ISS space toilets. Apparently, this is part of a series of videos he and his one-man film crew did. (The Tiangong astronauts also do presentations, in their case for Chinese schoolchildren,)

NASA wants to have first commercial space station up by 2028 to avoid a space gap.

We watched a video of the release of the Webb Space Telescope, including the extension of the solar panels.

We need to get the sections of the annual report done by the next meeting so Tim can submit them.

We have $920.82 in the checking account and $267 in cash for a total of $1187.82.

Minutes by OSA Secretary Syd Henderson

Minutes of February 12 Chapters Assembly (from Dennis Pearson)

ACTION ITEMS BY CHAPTERS

1) On the request of Bennett Rutledge of the Denver NSS Chapter who is the current Chapter Chair, Dennis Pearson of the Philadelphia Area Space Alliance made the motion that Dale Amon shall receive all our Chapter Assembly minutes, and other documents and resources authorized by the Chapter Assembly in a condense zip file via Dropbox and archive them for storage at a facility that could be accessed by future space scholars. This motion was seconded by Keith Dauzat of Texas Clear Lake Area Chapter,

The Chapter Assembly Chapters present for this ZOOM virtual meeting recorded their vote on the motion in Chat and after time was allowed for the vote Bennett Rutledge the Chair ruled that while the motion appears at the moment to be in the affirmative according to CA Bylaws the vote must remain open until the Minutes are distributed to all official US and International CA chapters so as those CA Chapters who were not in attendance can record their votes and would allow Chapters who were in attendance to change their vote if directed so by members of their Chapter … Chapters which haven't

voted or wish to change their vote have until March 13 , 2022 to record their vote ... The Official vote will be announced at the next CA meeting on March 14, 2022 ... But realistically for all intents and purposes the motion at the moment appears largely in the affirmative.

2), On Saturday, April 23, 2022, the Sacramento L5 Society with the sponsorship of the NSS Chapters Assembly will conduct the 7th in a Series of Breakfast on the Moon Webinars hosted by Joseph Bland, a former Chapter Assembly Chair.

By discussion earlier during the meeting Bland asked for suggestions on what people should be approached to become panelists on the final two webinars of the series and what topics should be discussed to continue the quality of what was being presented. Bland expressed pride that this partnership might be the only partnership that covered all the 50th Anniversaries of the Apollo Program Moon Landings including the one that failed in that attempt, but the heroism shown in that flight made it a successful failure.

The following is Bland's letter on Chat which he offered for the CA Assembly's to advertise the upcoming Apollo 16 and Apollo 17 Breakfast on the Moon Webinars.

> "a) Regarding Breakfast on The Moon Apollo 16 and 17 Celebrations of Apollo's 50th anniversary: On Saturday morning, April 23rd, 2022, 7:00-8:30 AM PDT, (the) NSS Chapters' Assembly and NSS chapter Sacramento L5 Society will host the sixth in their ongoing series of 50th anniversary celebrations of the manned Apollo missions to the Moon. The NSS Chapters' Assembly is requesting the involvement of the NSS leadership in helping to make this celebration and the final celebration for Apollo 17 (in December 2022 with time and date to be decided) as special as possible. Please contact ASAP Joe Bland at joe.bland@nss.org with thoughts and ideas on how to best celebrate these last two events. (For the Apollo 15 event, we had Apollo Mission Control Flight Director Gerald D. Griffin return as principal panelist. He was joined by author and NSS Director of Communications and Branding Dr. Anthony Paustian. Joseph Bland, president of the Sacramento L5 Society, was the Zoom host.
>
> "For this celebration, we will be utilizing a Zoom webinar with at least a 500-seat capacity. That permits a "panelist" type of presentation with submitted questions from those attending. The presentation will occur from 7:00 AM to 8:00 AM PDT, and a Q&A will follow from 8:00 AM to 8:30 AM. We will also simulcast on YouTube Live on the Sacramento L5 Society YouTube channel: https://www.youtube.com/channel/UC30Nu--k19f3t7qoZjhtgHA
>
> "b) Motion Made by Joseph Bland of the Sacramento L5 Society and 2nd by Dennis Pearson that this letter or announcement be sent to the NSS Chapter Assembly members, and all NSS discussion groups, and Fred Becker's Download list committees and all electronic or printed media who may be interested in advertising and promoting this event
>
> "c) The Chapter Assembly Chapters present for this ZOOM virtual meeting recorded their vote on the motion in Chat and after time was allowed for the vote Bennett Rutledge the Chair ruled that while the motion appears at the moment to be in the affirmative according to CA Bylaws the vote must remain open until the Minutes are distributed to all official US and International CA chapters so as those CA Chapters who were not in attendance can record their votes and would allow Chapters who were in attendance to change their vote if directed so by members of their Chapter … Chapters which haven't voted or wish to change their vote have until March 13 , 2022 to record their vote ... The Official vote will be announced at the next CA meeting on March 14, 2022 ... But realistically for all intents and purposes the motion at the moment appears largely in the affirmative. With Rutledge taking the liberty to authorize Joseph Bland to move quickly on all the planning and advertising for these upcoming events."

3) Affirmed by voice vote that the Chapter Assembly's ISDC in-person and virtual meeting in Alexandria VA will be held at 10 AM EST on Saturday, May 28, 2022. The agenda of that meeting not yet determined will be announced prior to that meeting. But by bylaws it is required that an election of a CA Executive Secretary be held. Dennis Pearson being the current Executive Secretary. It was also decided by voice vote that the NSS Chapter Committee which normally had a dinner to present its various Chapter

Achievement awards at the ISDC in light of a shortened ISDC this year be allowed to use the back half of our scheduled time to make their awards/

4) CA Chapters also are reminded to file their 2021 Financial and Activities reports to the NSS Chapter Committee so as not to be put on probation or suspended. So, it is important to all Chapters to file these reports to be considered for awards.

Space News

Although Jupiter is well-known for its Trojan asteroids (over 11,000 to date), most of the other planets have a few. Exceptions are Mercury and, oddly, Saturn. Venus has one known and Uranus has two. Orbital mechanics tent to make their Trojans temporary. Mars has 14 known, and Neptune 28. Even Ceres and Vesta have some. And what of Earth? We now have two known. The first was first seen in 2010 and was confirmed to be an Earth Trojan the following May. The second, 2020 XL_5 was confirmed last year. They're both tiny. 2010 TK_7 is about 400 yards across and 2020 XL_5 around three-quarters of a mile. They're also not in stable orbits. Indeed, although both are near the Earth-Sun L4 point, 2010 TK_7 orbited L5 around 1500 hundred years ago and moved to L4 through L3. 2020 XL_5 will stay a Trojan for another four thousand years.

Apollo 16 50th Anniversary

Apollo 16 was the penultimate lunar mission of the Apollo Program, lasting from April 16 – 27, 1972. Interestingly, we have met all three astronauts in earlier Apollo missions. This was John Young's fourth space mission after *Gemini 3* and *Gemini 10*, and *Apollo 10*, on which he served as Command Module Pilot which meant he got to see Tom Stafford and Eugene Cernan try out the Lunar Module in lunar orbit. On *Apollo 16*, he was Commander and got to walk on the Moon. He also became the second American after Jim Lovell to fly in space four times. He would make it five with the first Space shuttle orbital launch (STS-1) and six with STS-9. He was the first person to do either. He is also the only person to fly aboard Gemini, the Apollo Command Module, the Lunar Module and the Space Shuttle.

Mattingly had served in the support crew of *Apollo 8* and *9* and was a "backup backup commander" for *Apollo 11*. What I mean by that is if the *Apollo 11* mission had been postponed beyond backup commander William Anders' set retirement date of July 31, Mattingly would have taken over as backup commander.

Charles Duke also played a role in Apollo 11: he was CAPCOM (spacecraft communicator), who was the person who communicated directly with the of the spacecraft. (The title is short for the earlier version, "capsule communicator). So, if you hear a person talking to the astronauts in films of Apollo 11, it is most probably Charles Duke (although on such a long mission, he would have had a backup.) He spoke the famous words "Tranquility, we copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot!" in response to "The Eagle has landed." During the Apollo and Shuttle eras, CAPCOM was generally an astronaut but since non-astronauts may perform the duty (except for dockings, EVA and the like).

All three astronauts were footnote persons in the *Apollo 13* drama. Young was backup Commander, with Charles Duke and Jack Swigert as the rest of the backup crew. Ken Mattingly was in the original crew with James Lovett and Fred Haise. When Duke came down with German measles, he exposed both crews to the disease, and Mattingly, who had never had it, was replaced by Swigert. Duke and Mattingly were to fly on *Apollo 16* with Young. It was the first spaceflight for both and the only one for Duke. Mattingly went on to command two Shuttle missions, including the fourth and final test flight of *Columbia*. John Young, of course, was the commander of the first test flight of *Columbia*, which was the first orbital Space Shuttle flight. John Young died in 2018 after an amazing space career. Duke and Mattingly are still alive as of this writing. I don't know if Mattingly has yet contracted German measles.

Back-up commander was *Apollo 13* veteran Fred Haise, who would have commanded *Apollo 19* if that had ever come to pass. This reflects the tendency to have the back up crew for one mission be the

crew three missions further on. The other backup crew were Stuart Roosa and Edgar Mitchell from *Apollo 14*, since they had run out of Apollo 13 astronauts (Lovell had gone twice, but Swigert would have been available at the time.)

Apollo 16 was the second of NASA's J-type missions, which concentrated on scientific investigations, in contrast with the H-type missions, *Apollo 12, 13* and *14*, which concentrated more on precision landing and exploration. (*Apollo 11* was the only G-type mission, which was just to land in the first place.) There was originally going to be an I-type, which would have been orbital surveillance, but that function was incorporated into the J-type missions, presumably to give the command module pilot this duty while orbiting.

After the Apollo 9 Command Module and LEM were named *Gumdrop* and *Spider*, and those for *Apollo 10* were *Charlie Brown* and *Snoopy*, NASA insisted on more serious names, but on *Apollo 16* the command module was named Casper as in Casper the Friendly Ghost (who unfortunately is not on the mission patch). The Lunar Module has the more ordinary name *Orion*, which means the Orion spacecraft has already flown. (Note that John Young was on both *Apollo 10* and *Apollo 16*, but apparently Mattingly chose the name *Casper*--he was, after all, the one in command of the module.)

There were some minor glitches on the way to the Moon and one major one: one of the sets of gimbals aboard *Casper* started oscillating, making the spaceship shake. This was shortly after *Orion* had undocked and it was uncertain whether the mission was aborted, since protocol was for a redocking. However, after several hours of deliberation by Mission Control, it was decided that, from similar tests on *Apollo 9*, that the landing could proceed. The delay meant the first moonwalk would occur on the second day of the mission.

Apollo 16 was the first Apollo mission to land on the Lunar Highlands and, since *Apollo 17* landed in a deep valley in another highland, I'd argue it's the only one. The Lunar Module landed in the Descartes Highlands, which are 7,400 feet higher than Tranquility base. These get their name from the 30-mile-wide Descartes Crater which about fifteen miles south of the landing site. Both are located about eleven degrees south of the lunar equator. The Apollo 16 landing site is between two more modest craters, North Ray (3300 feet in diameter), and South Ray (2230 feet in diameter). By way of comparison, Meteor Crater in Arizona is 3900 feet in diameter, so these are still quite large.

The high albedo (reflectivity) of this region of the Moon led scientists to believe the region might consist mostly of volcanic rock, but that turned out not to be the case. The rocks collected by the crew were mostly breccia, which is a conglomerate of smaller rocks. In this case, the rocks turned out not to be igneous.

John Young was the first to step on the surface. His immortal words, "There you are: Mysterious and unknown Descartes Highland Plains. Apollo 16 is gonna change your image. I'm sure glad they got ol' Brer Rabbit, here, back in the briar patch where he belongs." Charles Duke's words were "Here I come babe! Hot dog is this great! Fantastic. That's the first foot on the lunar surface. It's super, Tony." [Tony England was the CAPCOM for the lunar EVAs.]

One of the first goals of the mission was to set up an instrument to measure the heat flow in the lunar interior. An earlier version had flown on *Apollo 15*, but the drill didn't work. This time it worked but unfortunately Young caught his foot on a cable and disabled the instrument irreparably.

The astronauts were more successful in their exploration and moon rock collecting. They used the Lunar Rover to visit both Stone Mountain, which contained South Ray, then North Ray, which is near Smoky Mountain, and numerous other craters. Duke lost his balance for a few seconds on the steep slopes of North Ray and almost fell on his delicate backpack, which would have been disastrous.

But it was at the smaller Flag Crater where they picked up their most famous sample, the 26-pound "Big Muley," the heaviest rock ever returned from the Moon. Duke commented on the beautiful crystals in it. In North Ray, they found a boulder the height of a four-story building, which they called House Rock. From this they were content to take small samples.

The result of their survey was that the region was not shaped by vulcanism but by impacts, particularly those that formed Descartes Crater and North and South Ray. Only one of their rocks appeared to be

igneous. That one was 4.47 billion years old and was excavated by the impact that created North Ray 50 million years ago.

The return to Earth was uneventful, with the gimbal oscillations not recurring. The Lunar Module did tumble after separation, but the astronauts were no longer aboard. It impacted the Moon early in 1973.

Sky Viewing

We had a wealth of evening sky planets last fall, which means they have all moved into the morning sky. Even **Neptune** is in conjunction with the Sun on March 13 (after which it, too, will be a morning star). That leaves **Uranus** as the only planet in the evening sky, and since it is magnitude 5.7, is pretty much impossible to see without binoculars. Even Uranus will be in conjunction with Sun on May 5, leaving only **Mercury** to hold the fort when it is an evening star.

Fortunately for evening sky gazers, this is also the time of year when Orion and Sirius are highest in the sky, as well as all the other first-magnitude stars Orion to which Orion is a pointer (Procyon, Pollux, Capella, and Aldebaran, as well as its own first-magnitude stars Betelgeuse and Rigel). Six of these stars form the Winter Hexagon; the seventh, Betelgeuse, is its red heart (and since it is variable, it's a beating heart). Another bonus is that the belt of Orion points not only to Sirius and Aldebaran, but also to the Pleiades.

In compensation, the morning sky has all those missing planets. Well, not **Jupiter** quite yet since it was in conjunction with the Sun on March 5 and is still lost in morning twilight. Jupiter will be visible before dawn at the end of March and will rise earlier each night until by April 30 Jupiter will be rising two hours before the Sun, which is also when it will have a spectacular conjunction with **Venus**. Unfortunately for us (but great for observers in the Eastern Hemisphere), the closest approach is at 2:00 p.m., when the apparent distance between the planets is a third the width of the full Moon, but they will be plenty close the mornings before and after. Since Venus will be magnitude -4.1 and Jupiter -2.1, they will be impossible to miss.

Venus was at its brightest in early February when it had an unusually close approach to Earth, and has faded a smidgen to magnitude -4.6, which is still outstanding. It is also rising well before the sun and dominates the sky before sunrise. The 1.3 magnitude "star" four degrees below Venus is **Mars**. Since they are both in the dimmest Zodiacal constellation, Capricornus, there are no nearby bright stars to confuse you. That includes **Saturn**, which is well away on the other end of Capricornus, and **Mercury** next door in Aquarius, both of which are much closer to the horizon and difficult to see.

Saturn, Mars and Venus will be together in the eastern part of Capricornus in late March and will all be within five degrees of each other on March 24. Venus's closest approach to Saturn is 2.2 degrees on March 28. Mars does better: on the morning of April 5, Mars and Saturn will be less than half a degree apart. By then, Saturn will be magnitude 0.9 and Mars 1.0, so they will look like twins.

April 22 is the peak of the **Lyrid Meteor Shower**. This shower produces ten to twenty meteors per hour and are bright since the radiant in Lyra will be almost overhead. However, the last-quarter Moon will interfere when it rises around 2:00 a.m.

Better (and it comes before the next issue of *Outreach*) is the **Eta Aquariid Meteor Shower**, which peaks on May 5 and can produces about fifty meteors an hour. This is one of the best meteor showers of the year although not as famous as the Perseids or Geminids and may be worth checking out. The radiant is in almost exactly on the Celestial equator, which is about fifty-five degrees above the horizon in Oklahoma.

There is also a partial eclipse of the Sun on April 30 which is only visible in southern South America and mostly empty regions in the southeast Pacific Ocean. (This is where reentering satellites go to die.) Better is the May 15 total lunar eclipse, which is visible from Oklahoma, but that is a subject for the next newsletter.

Viewing Opportunities for Satellites (March 12 – April 12, 2022)

You can get sighting information at www.heavens-above.com, which gives you a constellation map showing the trajectory of the satellite. The Sky & Telescope web site carries ISS observation times for the next few nights at skyandtelescope.com/observing/almanac. You can also get data at https://spotthestation.nasa.gov/sightings/.

With the addition of the solar panels, the International Space Station can be as bright as magnitude -4.0 making it brighter than all the stars other than the Sun and all the planets other than Venus, although magnitude -2 to -3 is more likely. The Hubble Space Telescope can get up to magnitude 1.5, which is brighter than the stars in the Big Dipper, but magnitude 2.0 – 2.5 is more likely. *Tiangong* is the Chinese Space Station. It currently gets up to magnitude 0.9 (as on March 27) but will get brighter as more modules are added. The "mag." beside the date indicates the brightest magnitude the satellite gets during the pass. All the ISS passes get between -3 and -4, which is brighter than Jupiter ever gets, but not quite as bright as Venus.

Missions to and from the International Space Station can change its orbit. A Soyuz spacecraft will launch on March 18 (although the undergoing Russian invasion of Ukraine may affect space cooperation.) The next mission from America is that of Axiom 1 on March 30 (delayed from last month). SpaceX's Crew-4 mission launches no earlier than April 15. There is also a return Soyuz flight on March 30, but this one has a NASA astronaut so things may get complicated (or not, since they land in Kazakhstan.)

The Tiangong pace station's second crew was launched on October 15 and will return in April. I'm sure there will be some resupply missions before then, but I have no dates.

The information below is from Heavens Above.

Tiangong 3/17/22 mag. 1.3

Time	Position	Elevation
8:21 p.m.	227°	10°
8:24:34	151	49
8:25:55	78	15

Vanishes into Earth's shadow

ISS 3/17/22 mag. -3.0

Time	Position	Elevation
8:51 p.m.	242°	10°
8:54	320	52
8:56:42	34	17

Vanishes into Earth's shadow

ISS 3/18/22 mag. -3.8

Time	Position	Elevation
8:03 p.m.	224°	10°
8:06	137	81
8:09	50	10

Tiangong 3/18/22 mag. 1.6

Time	Position	Elevation
8:55 p.m.	262°	10°
8:57:50	340	52
8:58:56	39	32

Vanishes into Earth's shadow

HST 3/21/22 mag. 1.9

Time	Position	Elevation
8:42 p.m.	238°	10°
8:45:53	175	30*
8:47:50	130	20

Vanishes into Earth's shadow
*Passes just south of Sirius

HST 3/22/22 mag. 1.9

Time	Position	Elevation
8:31 p.m.	241°	10°
8:34:23	178	31*
8:37:06	122	15

Vanishes into Earth's shadow
*Passes just south of Sirius

HST 3/23/22 mag. 1.9

Time	Position	Elevation
8:19 p.m.	243°	10°
8:23	180	32*
8:26	118	11

*Passes just south of Sirius

HST 3/24/22 mag. 1.9

Time	Position	Elevation
8:08 p.m.	245°	10°
8:11	183	31*
8:15	120	10

*Passes just south of Sirius
(After this pass this series of passes HST is lost in twilight at dawn)

Tiangong 3/27/22 mag. 0.9

Time	Position	Elevation
9:09 p.m.	253°	10°
9:11:58	206	83
9:12:15	135	40

Vanishes into Earth's shadow

Tiangong 3/29/22 mag. 1.6

Time	Position	Elevation
8:38 p.m.	286°	10°
8:41:20	210	49*
8:43:31	1:38	16

Vanishes into Earth's shadow
Passes midway between Betelgeuse and the Belt of Orion, then midway between Sirius and Procyon

ISS 4/4/22 mag. -3.7

Time	Position	Elevation
8:57 p.m.	310°	10°
9:00:29	224	79
9:02:16	40	26

Vanishes into Earth's shadow

Key: Position is measured in degrees clockwise from north. That is, 0° is due north, 90° is due east, 180° is due south, and 270° is due west. Your fist held at arm's length is about ten degrees wide. "Elevation" is elevation above the horizon in degrees. Thus, to find the Tiangong Space Station at 8:41 p.m. on March 29, measure three fist-widths west of due south then five fist-widths above the horizon.

Programming Notice: NASA TV on the Web

Watch NASA TV (Public, Media and Education Channels) on your computer using Flash, Windows or QuickTime at http://www.nasa.gov/multimedia/nasatv/index.html.

NASA TV Schedules are available at http://www.nasa.gov/multimedia/nasatv/schedule.html.

Note that the ongoing Russian invasion of Ukraine may complicate things, although the March 18 launch is all Russian.

March 18: 10:15 a.m.: Coverage of the launch of Soyuz MS-21 crew to the ISS. (Actual launch is 10:55 a.m.) 1:15 p.m.: Coverage of rendezvous and docking. (Docking is at 2:05 p.m.) 4:15 p.m.: Coverage of hatch opening (scheduled for 4:30 p.m.)

March 29, 11:15 p.m.: Coverage of hatch closure for Soyuz MS-19 which is returning two cosmonauts and one NASA astronaut. (Actual closure 11:40 p.m.)

March 30: 2:45 a.m. Coverage of undocking of Soyuz MS-19 from the ISS.) (Undocking at 3:04 a.m.) 5:15 a.m.: Coverage of deorbit burn and landing, with actual landing in Kazakhstan at 6:26 a.m.

The Axiom-1 mission is also scheduled for March 30, but no NASA-TV events have been mentioned. The April 15 Space-X Crew-4 mission will undoubtedly be covered, but that's ahead of the current NASA-TV schedule.

Calendar of Events

March 12 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

March 13: Neptune is in conjunction with the Sun.

March 18: Launch of Expedition 67/68 to the ISS from Baikonur, carrying a three-person Russian crew.

March 20: Venus is at greatest western elongation, 46.6 degrees from the Sun (hence can be seen before sunrise).

March 30, 1:36 p.m. [Moved from February 28]: Launch of *Axiom Space Mission 1* which will carry a commercial crew of four to the ISS via SpaceX Crew Dragon. For more information, see https://en.wikipedia.org/wiki/Axiom_Mission_1

Mid 2022: [Moved several times]: Maiden flight of the Vulcan Centaur, ULA's new heavy launch vehicle. which will carry the Peregrine lunar lander. For more information, visit https://en.wikipedia.org/wiki/Vulcan_(rocket) and https://en.wikipedia.org/wiki/Astrobotic_Technology#Peregrine_lander.

Mid 2022: First SpaceX *Starship* orbital test flight,

April: Transporter 4 launch aboard a Falcon 9 Block 5, carrying a slew of small satellites and CubeSat deployers. This flight includes Tanzania's and Albania's first satellites.

April 2: Mercury is at superior conjunction with the Sun.

April 4: Mars is 0.3° south of Saturn.

April 9 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

April 12: Neptune is 0.1 degrees below Jupiter.

April 15: Launch of SpaceX Crew-4 mission to the ISS.

April 16 – 27: 50th anniversary of Apollo 16.

` April 22: Peak of Lyrid meteor shower.

April 23, 9:00 – 10:30 a.m. (CDT) Breakfast on the Moon Apollo 16 & 17 Celebrations of Apollo's 50th anniversary. See Minutes of Chapter Assembly meeting for more information, including log in information.

April 29: Mercury is at greatest eastern elongation 20.6°from the Sun (so can be seen after sunset).

April 30: Partial eclipse of the Sun, visible from the southern tip of South America, parts of Antarctica, and lots of ocean.

April 30: Venus is only 0.2° south of Jupiter.

May: Third crew to the Chinese Space Station. Also launch of *Wentian*, the first lab module to the station.

No earlier than May: Earliest launch date for *Artemis 1* the first launch of the Space Launch System. On this uncrewed launch NASA launches the Lunar IceCube, Lunar Polar Hydrogen Mapper, and Lunar Flashlight lunar orbiters, in addition to Japan's OMOTENASHI cubesat lunar lander. For more information, see https://en.wikipedia.org/wiki/Lunar_IceCube, the Near-earth Asteroid Scout cubesat (https://en.wikipedia.org/wiki/Near-Earth_Asteroid_Scout)and a bunch of other satellites.

May 5: Uranus is in conjunction with the Sun.

May 5: Peak of the Eta Aquariid meteor shower.

May 14 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

May 15: Total lunar eclipse, visible from all of South America and Antarctica and the eastern half of North America. It looks like Oklahoma gets most of this.

May 20: (Unmanned) Orbital test launch 2 of Boeing Starliner.

May 21: Mercury is at inferior conjunction with the Sun.

May 26: Venus is 0.2° north of the Moon as seen from Oklahoma. This is an occultation from some parts of the Earth.

May 29: Mars is 0.6° south of Jupiter.

June: Launch of *Firefly Alpha* carrying the Elana 43 mission.

June: Launch of Virgin Orbit's *LauncherOne* from Spaceport Cornwall in England.

June 11 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence.

June 15 [Postponed from May/]: Second flight of South Korea's *Nuri*, and the first with a commercial payload.

June 16: Mercury is 23.2 ° west of the sun so can be seen before sunrise.

Second half of 2022: Launch of *ALINA* (the Autonomous Landing and Navigation Module) near the *Apollo 17* landing site. This will land two rovers which will search for Apollo 17's lunar rover.

Second half of 2022: Launch of SLIM, the Smart Lander for Investigating Moon, a Japanese lunar lander. Another JAXA spacecraft, *XRISM*, the X-Ray Imaging Spectroscopy Mission (pronounced "krism") launches on the same flight. For more information, see

https://en.wikipedia.org/wiki/Smart_Lander_for_Investigating_Moon and https://en.wikipedia.org/wiki/X-Ray_Imaging_and_Spectroscopy_Mission.

Second half of: Launch of *Eris*, the first Australian rocket to launch an Australian payload. *Eris* is the launch vehicle for Gilmour Space.

Third quarter of 2022 [moved from January]: India launches Aditya-L1 to the Earth-Sun L1 point, on a mission to study the Sun's corona. For more information, visit https://en.wikipedia.org/wiki/Aditya-L1.

Third quarter of 2022: Maiden flight of Ariane 6.

Third quarter of 2022: Maiden flight of Taiwan's Hapith V.

Third quarter of 2022: First commercial smallsat mission to Mars, launched by Virgin Orbit from Mojave

July 16: Mercury is in superior conjunction with the Sun.

July 22: Launch of the Luna 25 lunar lander, the first mission of Russia's Luna-Glob lunar exploration mission. This will land near Boguslawsky Crater about 77 degrees South on the Moon. For more information, visit en.wikipedia.org/wiki/Luna_25 and en.wikipedia.org/wiki/Luna-Glob.

July 28: Peak of the Delta Aquariid meteor shower.

August: Launch of *Mengtian*, the second laboratory module to the *Tiangong* space station.

August 2022: India launches Chandrayaan-3, which will include a lander and a long-lived rover which will explore craters around the Moon's South Pole in search of ice. See https://en.wikipedia.org/wiki/Chandrayaan-3

August 1: Launch of *Psyche*, which will orbit a large metallic asteroid also named Psyche. For more information, visit https://en.wikipedia.org/wiki/Psyche_(spacecraft).

August 1 (postponed from December 2020]: Launch of the *Korea Pathfinder Lunar Orbiter* (KPLO) and lunar impactor from Naro Space Center in South Korea. For more information, see https://en.wikipedia.org/wiki/Korea_Pathfinder_Lunar_Orbiter.

August 12: Peak of the Perseid meteor shower.

August 14: Saturn is at opposition.

August 27: Mercury is at greatest eastern elongation, 27.3° from the sun (so it can be seen before sunset.)

September: First *UK Pathfinder* launch from SaxaVord Spaceport in the Shetland Islands (probably). Amazingly, this appears to be the first orbital launch from the United Kingdom. (**CORRECTION**: Virgin Orbit will be if it launches in June—and it actually launches from Cornwall.)

September 20 [postponed from 2020]: ESA launches the *ExoMars Mars Rover*, which has been christened *Rosalind Franklin*, and the Russian Kazachok surface platform. For more information, visit https://en.wikipedia.org/wiki/ExoMars.

September 23: Mercury is in inferior conjunction with the Sun.

September 26: Jupiter is at opposition.

Fourth quarter of 2022: First flight of Blue Origin's *New Glenn* orbital rocket. For more information, see https://en.wikipedia.org/wiki/New_Glenn.

Fourth quarter of 2022 [Moved from 2020.] Launch of the European Space Agency's *Euclid* space telescope. This will map the distribution of dark matter and search for evidence of dark energy. The Euclid website is https://sci.esa.int/web/euclid.

Fourth quarter of 2022: Launch of the *Einstein* X-ray astronomy probe by China.

Fourth quarter of 2022: Launch of *Axiom-2* mission to the ISS, via Falcon 9. This carries one professional astronaut and three private astronauts.

October: Launch of *Hakuto-R* mission 1, Japan's lunar lander. (Hakuto is Japan's Moon rabbit, so is equivalent to China's Jade Rabbit). For more information, see https://en.wikipedia.org/wiki/Hakuto. The same Falcon rocket will launch the *Rashid* lunar rover for the United Arab Emirates.

October 8: Mercury is at greatest western elongation, 18.0° from the Sun (so can be seen before sunrise).

October 21: Peak of the Orionid meteor shower.

October 22: Venus is at superior conjunction with the Sun.

October 25: Partial eclipse of the Sun visible from Europe, western Asia (including India) and northeastern Africa.

October 25: Fifth Crew Dragon mission to the ISS.

November: Launch of *Polaris Dawn* flight carrying four civilians into space, led by Jared Isaacman.

November: Launch of fourth crew to the *Tiangong* space station.

November 5: Peak of the South Taurid meteor shower.

November 8: Total lunar eclipse over all of the Pacific Ocean. Oklahoma will get most of this eclipse.

November 8: Mercury is in superior conjunction with the Sun.

November 9: Uranus is at opposition.

November 17: Peak of Leonid meteor shower.

December: Launch via Falcon 9 of the *Nova-C* lander and other cargos to the Lunar South Pole.

December 7: Mars is at opposition.

December 7 – 19: 50th anniversary of Apollo 17. This, to date, is the last manned mission to the Moon.

December 14: Peak of Geminid meteor shower.

December 21: Mercury is at greatest eastern elongation, 20.1° from the sun (hence can be seen after sunset.)

December 22: Peak of Ursid meteor shower.

Sometime in 2023: India launches its first crewed orbital flight *Gaganyaan-3*.

Sometime in 2023 (Really tentative): launch of *#dearMoon*, which will carry six to eight artists on a lunar free-return mission.

Sometime in 2023: Rocket Lab launches an atmospheric probe and flyby to Venus.

First quarter of 2023: First Dream Chaser cargo mission.

March 2023: First crewed launch of *Boeing Starliner-1* to the ISS. Note: I had this down for April 2022, but due to recurring valve problems with the Starliner test vehicle, it keeps getting pushed.

April – July 2023: The *ExoMars* Mars landers land on Mars. This includes the Russian Kazachok surface platform and the ESA's Rosalind Franklin Mars rover.

Mid 2023: First launch of Firefly's *Blue Ghost* lunar lander.

May 2023: Launch of Venus Life Finder probe as well as the *Photon* relay satellite.

June 2023 [approximate, moved from 2022]: First crewed launch of an Orion space capsule.

August 2023: [Moved from August 2022] Launch of *JUICE*, the Jupiter Icy Moons Explorer, by the European Space Agency. The JUICE web site is https://sci.esa.int/web/juice .

September 2023: First crewed test flight of SLS and Orion. This will be a free-return mission: that is, it will loop around the Moon without landing.

September 24, 2023: *OSIRIS-REx* returns samples from Asteroid Bennu.

Fourth quarter of 2023: Launch of *Hakuto-R* mission 2, Japan's lunar lander and rover. For more information, see https://en.wikipedia.org/wiki/Hakuto.

October 14, 2023: Annular eclipse of the Sun. The path where it is annular extends from the coast of Oregon, northern Nevada, Utah, central New Mexico, and southwestern Texas (including Austin and San Antonio), thence lengthwise through Yucatan and Central America, then Colombia and northern Brazil. This will be partial from Oklahoma with 80% of the Sun covered. This makes a good prelude to the total eclipse the following April.

November 2023: Launch of NASA's *VIPER* lunar rover, which will hunt for ice near the at Nobile Crater at Moon's South Pole. VIPER is landing aboard Astrobotic's *Griffin* lunar lander. They leave Earth aboard a Falcon 9.

November 2023: Launch of *Maste*n Mission One lander and MoonRanger rover on the Moon via Falcon 9.

December 15, 2023: uncrewed test launch of *Orel*, Russia's new crewed spacecraft. For information, https://en.wikipedia.org/wiki/Orel_(spacecraft).

Sometime in 2024: China launches its *Xuntian* space telescope, which will orbit close to orbit close to *Tiangong* for easy servicing.

First half of 2024: Israel launches its *Beresheet 2* lander and orbiter on the Moon.

April 8, 2024: Next total eclipse of the Sun visible in the United States. This one will be visible on a path through northern Mexico (making landfall opposite the tip of Baja California), passes through Texas (including Dallas, Arlington, and Waco), touches the southeastern corner of Oklahoma, then crosses Arkansas, eastern Missouri, Illinois, western Kentucky, Indiana, Ohio (including Cleveland), Erie in Pennsylvania, upper New York (including Buffalo and Niagara Falls), Burlington in Vermont, New Hampshire, and Maine, then into Canada.

May 2024: Commercial Lunar Payload Services mission delivers a lunar lander in Schrödinger Basin,

September 2024: Launch of Japan's *Martian Moons Exploration* (MMX) which includes a Phobos lander and sample return. For more information, see https://en.wikipedia.org/wiki/Martian_Moons_eXploration_(MMX).

October 2024: Planned date of *Artemis 3*, which will land astronauts on the Moon for the first time since 1972.

October 2024: Launch of *Europa Clipper* orbiter. For more information, https://en.wikipedia.org/wiki/Europa_Clipper,

November 2024: (Tentative): Launch of the first two modules of the Lunar Orbiter Platform- Gateway. These were originally going to be launched on separate spacecraft but are now bunked together.

December 24, 2024: Parker Solar Probe (formerly Solar Probe Plus) makes its first pass through the outer corona of the Sun. For more information, see http://parkersolarprobe.jhuapl.edu.

Sometime in 2025 [moved from 2024]: India launches its *Mangalayaan–2* Mars mission, which includes an orbiter, lander, and rover.

Sometime in 2025: Launch of NEM-1, the core module of the Russian Orbital Service Station. For more information, see https://en.wikipedia.org/wiki/Russian_Orbital_Service_Station.

September 2025: First crewed flight of Russia's Orel (formerly called Federatsiya).

December 2025: Launch of the *Nancy Grace Roman Space Telescope* [formerly known as WFIRST]. For more information, see https://en.wikipedia.org/wiki/Nancy_Grace_Roman_Space_Telescope.

December 2025: *BepiColombo* arrives at Mercury orbit.

January 31, 2026: The *Psyche* asteroid probe arrives at the asteroid 16 Psyche. For more information, visit https://en.wikipedia.org/wiki/Psyche_(spacecraft).

July 2026: Launch of the *Sample Retrieval Lander* to Mars. This is the lander which will bring take the samples taken by *Perseverance* to orbit.

July 2026: *Hayabusa 2* flies by asteroid 2001 CC_{21}.

October 2026: Launch of the ESA's Earth *Return Orbite*r to Mars. This is the vehicle that will bring the *Perseverance* Mars samples to Earth.

June 2027: Launch of *Dragonfly*, the Titan helicopter mission.

August 12; 2027: *Lucy* flies by asteroid 3548 Eurybates in its first encounter with a Trojan asteroid. It will fly by at least 3 more Trojans in 2027 and 2028.

Sometime in 2028: Launch of *VERITAS* to Venus.

First quarter of 2028: Launch of the *Emirates Asteroid Mission*.

Sometime in 2029: Launch of the *ARIEL Space Telescope* and the *ESA/JAXA Comet Interceptor* mission via Ariane 62.

Fourth quarter of 2029: Launch of *DAVINCI+* to Venus.

October 2029: *JUICE* achieves Jupiter orbit. [See 2022.]

Sometime in 2033: *JUICE* achieves Ganymede orbit. [See 2022.]

December 2034: *Dragonfly* arrives at Titan.

August 12, 2045: The next total solar eclipse visible in Oklahoma City. This one is also visible in Salt Lake City, Denver, Little Rock (again), Tampa Bay and New Orleans.

Oklahoma Space Alliance Officers, 2022

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Other Information

Oklahoma Space Industrial Development Authority (OSIDA), 401 Sooner Drive/PO Box 689, Burns Flat, OK 73624, 580-562-3500. Website is http://airspaceportok.com/#home,

Science Museum Oklahoma (former Omniplex) website is www.sciencemuseumok.org. Main number is 602-6664.

Tulsa Air and Space Museum, 7130 E. Apache, Tulsa, OK 74115.
Web Site is www.tulsaairandspacemuseum.com. Phone (918) 834-9900.

The Mars Society address is Mars Society, Box 273, Indian Hills CO 80454. Their web address is www.marsociety.org.

The National Space Society's Headquarters Executive Director e-mail nsshq@nss.org. The Chapters Coordinator is Bennett Rutledge 720-641-7987, rutledges@chapters.nss.org. The address is: National Space Society, PO Box 98106, Washington DC 20090-1600 Web page is space.nss.org.

The Planetary Society phone 626-793-5100. The address is 65 North Catalina, Avenue, Pasadena, California, 91106-2301 and the website is www.planetary.org. E-mail is tps@planetary.org.

NASA Spacelink BBS 205-895-0028. Or try www.nasa.gov. .

Congressional Switchboard 202/224-3121.

Write to any U. S. Senator or Representative at [name]/ Washington DC, 20510 (Senate) or 20515 [House]

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