

OKLAHOMA SPACE ALLIANCE

OUTREACH –July 2020

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will have
a Zoom meeting online at 2:00 p.m.
on July 11 details inside



Figure 1 Ingenuity, the first Mars Helicopter (NASA Gallery)

OKLAHOMA SPACE ALLIANCE OUTREACH July 2020

July Meeting

Due to ongoing concerns of some of our doctors, we are once again delaying the restart of in-person meetings for Oklahoma Space Alliance for another month or two. This month we'll have our online chapter meeting via Zoom.

The meeting will begin promptly at 2 PM on Saturday, July 11. Please sign into the meeting as close to this time as you can. If you have a camera, please start the video so we can see each other's shining faces. The free Zoom account allows only 40-minute meetings for 3 or more people, and the timer starts when the third person joins the meeting. Once that meeting times out, we can restart using the same link after 15 minutes have elapsed, so the plan will be to take a break at about 2:40 and resume for part two of the meeting at 3 PM. (Note, though, that last month Zoom extended our time so we didn't have to divide the meeting.)

For the meeting ID and password, contact Kip at 863-6173 (email cliffmcmurray at hotmail.com) or Syd Henderson at 365-8983 (e-mail sydh at ou.edu) and we will send you the information.

If you have any questions about any of this, or want to do a quick practice session to avoid hiccups on Saturday, feel free to give me a call at (405) 863-6173 in the afternoon or evening on Friday. We hope to see you Saturday.

Saturday July 11, 2020 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
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
 - a. Review OSA treasurer's report
 - b. Minutes of June Meeting
 - c. Future Activities (Space week?)
5. Video (to be announced)
6. Chat

Minutes of June Meeting

Oklahoma Space Alliance chapter of National Space Society had its regularly scheduled meeting on June 13. However, due to the ongoing Covid-19 pandemic, we held the meeting online via Zoom. Attending the meeting were Clifford and Claire McMurray, Dave Sheely, Tim Scott, Robin Scott and Syd Henderson. Robin, who is the chapters correspondent for NSS Downlink, attended from Alabama. 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/Update2006.pdf>. We initially were going to have to meet for forty minutes, then take a break and return later, because of time limit on free Zoom meetings, but Zoom extended our limit during the meeting.

Since this was our first online meeting, there were a few glitches getting videos to play. We had to listen to a video tour of *Endeavour* (the SpaceX Crew Dragon that was their first manned launch), but later got the video to play and watch it again. I watched the docking and knew that there was a glittery stuffed dinosaur aboard and was glad to be introduced.

Starlink now has 422 satellites in orbit. There will be thousands by the time SpaceX completes the network. If you count backups, it's tens of thousands.

Dave reported on the OSIDA meeting. They are meeting online for the same reasons we are. Craig Smith is the new Executive Director, replacing Bill Khourie, who had been Executive Director for a couple of decades.

Sixteen years after SpaceShipOne went into space, we still do not have commercial manned spaceflight.

We now have \$672.94 in the checking account and \$267 in the cash box, for a total of \$939.94.

Robin is doing info gathering for *NSS Downlink*. I put her on our mailing list and sent her *Outreach* and *Update*.

We discussed whether to keep using Zoom. [There was concern about them blocking a Hong Kong blogger who wanted to do a memorial on the Tiananmen Square massacre. The Chinese government asked (probably demanded) that they do so. Kip investigated other hosting sites, and they all seemed to have feet of clay.]

--Minutes by OSA Secretary Syd Henderson

Space News

July 2020 is going to be a busy month for launching to Mars. The window for launches comes only every 26 months, and this year that falls in July and August. Since it's better to launch near the beginning of the window so that you have more leeway for delays, three spacecraft, one from NASA, one from China, and one from the United Arab Emirates, are all scheduled to launch in July. Originally, it was going to be four, but the Exomars rover *Rosalind Franklin* has had its launch delayed to the third quarter of 2022 because of problems testing the parachute.

The United Arab Emirates Mars orbiter *Hope* (in Arabic, *Al Amal*) is the first interplanetary probe for the UAE, which has only had a space program since 2014. Their space team is, not surprisingly, very young, with their science team having an average age of 27, and incidentally, 80% women.

Hope is a bit different than other Mars orbiters in that it won't orbit close to Mars. Instead, it will have an elliptical orbit which is 12,000 miles from Mars at closest approach and 25,000 miles when it is farthest away. By comparison, Mars's outer moon Deimos is 14,500 miles from Mars. The reason for the big orbit is that *Hope* is designed to observe long-term weather patterns on Mars and a slower orbit makes that easier. I'm not sure why the orbit is so eccentric, but it does give data that complements closer-in weather satellites such as MAVEN.

Of course, *Hope* is also a project designed to inspire young people throughout the Arab world, and to boost scientific development for a time when the oil runs out. There's also a matter of national pride, reflected by the arrival at Mars being scheduled for the 50th anniversary of the unification of the UAE.

Hope is scheduled to be the first of July's three launches to Mars, leaving on July 14 from Tanegashima, Japan aboard a Mitsubishi H-IIA rocket. This launch window is time-sensitive, presumably due to the complexity of getting into such a large orbit.

Second to be launched is China's ambitious *Tianwen-1* mission [previously called "Huoxing-1"], which consists of an orbiter, lander and rover. This would make it the first space power to land something on Mars on their first mission. The rover has a mass of 240 kg (528 lb.), which is about a third the mass of *Spirit* and *Opportunity*, but 20 times that of *Sojourner*. Among its instruments is ground-penetrating radar capable of imaging 330 feet beneath the Martian surface, which is handy for locating ice pockets. The landing spot is in Utopia Planitia south of where *Viking 2* landed, though the exact spot depends on reconnaissance from *Tianwen-1*'s orbiter. It's also not far from Isidis Planitia, which contains Jezero crater where *Perseverance* will be landing.

Among many other instruments, the orbiter carries a high-resolution camera equal to any currently orbiting Mars. The best is that aboard the *Mars Reconnaissance Orbiter*, which was launched in 2005 and presumably will die one of these days. (Its primary mission ended in 2010.)

I haven't seen any information on the lander, so I wonder if it simply provides support for the rover.

Incidentally, "Tianwen" means "Heavenly Questions." The previous name, "Huoxing" simply meant "Mars," which is why you heard the mission called *Mars 1*.

The launch date for the *Mars 2020* mission, which features the rover *Perseverance*, was recently moved from July 17 to 30, which puts it rather late in the launch window (although it has until August 11). The mission includes the rover and an attached helicopter named *Ingenuity*, as well as a sky crane to lower the payload (similar to how *Curiosity* was lowered), and descent stage. The sky crane is necessary because *Perseverance* is the heaviest rover ever to land on Mars, some 17% heavier than *Curiosity*. Most of the extra weight is in instruments.

Perseverance is based on *Curiosity*, but its purpose is different. *Perseverance* is landing in Jezero crater, which is the site of an ancient lake, and two former riverbeds and a large delta indicate that the rivers emptied into the lake. This is a prime spot to look for signs of primordial life, and *Perseverance* is designed to do that. For this reason, it has both an X-ray spectrometer and an ultraviolet laser to detect signatures of past life, and a ground-penetrating radar to examine the soil to thirty feet. *Perseverance* also possesses 23 cameras. The Mastcam even has zoom capacity.

Perseverance is also preparing for the future, collecting and caching samples that will be brought back in two other missions that will launch to Mars in 2026. These will take the samples to a Mars orbiter that will return them to Earth sometime around 2031.

One experiment that I haven't seen widely publicized is MOXIE, which converts carbon dioxide into oxygen at the rate of ten grams per hour. This is not really fast enough to make reactant for a return flight but is a beginning for bigger things. The reaction being tested uses electricity to turn the carbon dioxide into carbon monoxide and oxygen. Scientists

need to be careful not to further disassociate the carbon monoxide into carbon and oxygen, because the carbon would build up and muck up the experiment.

One of the reasons to cache the samples now is that scientists want to beat contamination of the Martian rocks when humans land on Mars.

The helicopter *Ingenuity* is more of a demonstration project than a scientific revolution. It weighs only four pounds and has a blade span of about four feet. It's capable of flying for 90 seconds at a time and will be able to photograph while its flying. Then it has to wait several days for its solar batteries to recharge. It's only designed to fly five times. All in all, it sounds like the equivalent of the Wright Brothers' first airplane, which led on to many greater things.

Mars 2020 doesn't have an orbiter to relay information to Earth. Instead, it will relay back through the *Mars Reconnaissance Orbiter*, *MAVEN*, and an ESA satellite. Relaying through the Chinese orbiter is apparently forbidden through a bill that blocks technology transfer to China.



Figure 2: Perseverance Rover as it will appear on Mars (NASA/Caltech)

Space-Related Articles

“Three Missions Head for Mars,” *Sky & Telescope*, July 2020, pp. 22 – 29. [See “Space News,” which contains some information from this article.]

A while back, scientists detected evidence of a Neptune-sized world orbiting an exoplanet. This would be, if confirmed, be the first exomoon to be discovered. But it appears we may have discovered six more. Actually, confirming that they are exomoons will be difficult, since doing so requires tiny variances in transit times of the parent planet across its star's disk.

<https://www.newscientist.com/article/2247150-astronomers-have-spotted-six-possible-exomoons-in-distant-star-systems/>

The July issue of *Astronomy* is “All About Stars,” and quite interesting, particularly the article “How Stars are Born and Die,” by Jim Kaler. This is a general survey article of the current state of knowledge. One thing that I was surprised to discover that newborn stars called T Tauri stars shoot out jets of gas from both poles as they accumulate mass from a disk around their equators. If this sounds familiar, it is the same mechanism that produces jets from the poles of black holes that are accreting matter, but on a smaller scale.

Sky Viewing

July and August will be particularly good months for sky viewing with Jupiter and Saturn reaching opposition within a week of each other in July (and Pluto and Pallas—all four oppositions occurring between July 12 and 20), Mars brightening almost to magnitude -2, Venus reaching maximum brightness in the morning, and the Perseid meteor shower peaks in August.

The two brightest stars in the Northern Celestial Hemisphere are also brilliant this month. Arcturus is southwest of the zenith after sunlight, while Vega is east of the zenith. If you see a bright star almost directly overhead in mid-evening, it's Vega.

It looks like we may even have a fairly bright comet this month Comet NEOWISE has stayed intact and was first magnitude passing the Sun, and will still be second or third magnitude when it appears in the evening sky (though twilight will be a problem), and get higher in late July. For a chart telling you where to look, see <https://skyandtelescope.org/astronomy-news/anticipation-grows-for-comets-neowise-and-lemmon/>. (Ignore the reference to comet Lemmon, which requires binoculars or a telescope to see.)

We have two meteor showers during July and August, the **Delta Aquariids** and the **Perseids**. The Delta Aquariids are divided into two sections, the southern section peaking in late July at about 18 meteors per hour and the northern in mid-August and peaking at ten meteors per hour. Although this is a pretty good shower, the radiant of the southern section is seventeen degrees below the Celestial Equator, so may be a little difficult to see. The whole shower lasts for about a month, as do the Perseids.

The Perseids are one of the major showers every year, peaking around August 12, give or take a couple of days. At peak, you can expect 50 -100 meteors per hour. This shower is also highly visible from the Northern Hemisphere since the radiant is nearly sixty degrees above the Celestial Equator, so by 3 a.m. it is almost overhead. The Perseids are best viewed between 11 p.m. and dawn, but meteors can be seen as early as 9:30 a.m. The moon will be just past last quarter on August 12, and will rise around midnight, which is not ideal since the radiant will only be halfway to the meridian. However, the Perseids last for several weeks, and you may be able to see them even better in the next few days.

Mercury is just past inferior conjunction with the Sun and won't be visible until mid-July. It's going to reach greatest elongation on July 22, but still will only be magnitude 0.2, which is hard to see before dawn, especially since Mercury is rather low in the sky. Matters get worse in August as Mercury is still low in the sky and approaches superior conjunction on August 17.

Venus is moving through Taurus at the moment and is about to pass through the Hyades star cluster (the horns of the Bull). On July 11 and 12, it will pass within a degree of the first-magnitude star Aldebaran, which is not really part of the Hyades but lies in the same direction. Venus is at its peak magnitude of -4.7, so is far brighter than the magnitude 0.8 Aldebaran. Venus will reach greatest elongation in August at which point it will be more than forty degrees above the horizon at sunrise.

Mars is in a period of rapid brightening leading up to its opposition in October. At the beginning of July, it was magnitude -0.5, at the end of July it will be magnitude -1.1 and by the end of August, it will be magnitude -1.8. It is currently rising about an hour after midnight, but by July 31 it will be rising in late evening and by August 31, at mid-evening. In the process, it will move through Pisces, briefly enter Cetus, return to Pisces, then travel across Aquarius.

Jupiter and **Saturn** are less than ten degrees apart in the eastern part of the constellation Sagittarius as they both reach opposition this month, Jupiter on July 14 and Saturn on July 20. They are both in retrograde motion against the sky throughout July and August. Jupiter is around magnitude -2.7 and Saturn is magnitude 0.2, and they will dim only slightly in August.

Uranus is magnitude 5.8 and in Aries, rising an hour after Mars. During August it will almost due south at sunrise. You can find a finder chart for Uranus at https://in-the-sky.org/findercharts/09uranus_2020_2.png.

Neptune is magnitude 7.9 and in Aquarius, rising about an hour before Mars. It will be high in the sky around midnight in August as it approaches opposition on September 11. You can find a finder chart for Neptune at https://in-the-sky.org/findercharts/10neptune_2020_2.png.

Pluto is at opposition on July 15 and is in eastern Sagittarius not far from Jupiter. In fact, the two planets were in conjunction on June 30 and will be less than a degree apart through July. There is a finder chart in the *July Sky & Telescope*, but it shows such a small area of sky it may not be useful, and Pluto is so dim you'd need a large telescope to see it.

The asteroid **Pallas** is at opposition on July 12, shining at magnitude 9.6 in the constellation Vulpecula (the little fox), which is nowhere near the ecliptic. This constellation is south of Cygnus the Swan and also borders Lyra, which is where Vega is, However, Vulpecula is at the far end of those constellations from Deneb and Vega. Under dark skies, you should be able to find Delphinus, which looks like a tadpole. Vulpecula is north of that.

Finally, the dwarf planet/asteroid **Ceres** is at opposition on August 28 at which point it will be magnitude 7.7 and in the southern part of the constellation Aquarius. This is a fairly inconspicuous part of that constellation but is not far from the first-magnitude star Fomalhaut in Piscis Austrinus. A finder chart is on page 50 of the August *Sky & Telescope*.

Viewing Opportunities for Satellites (July 11 – August 11, 2020)

You can get sighting information at www.heavens-above.com, which allows you to get satellite-viewing data for 10-day periods and gives you a constellation map showing the trajectory of the satellite. The times below are from the NASA site <https://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/JavaSSOP/JavaSSOP.html>. It gives coordinates at 20-second intervals from when the satellite rises, not from when it peaks. (This program requires Java. I'm currently using Internet Explorer to run it and making an exception for the site in the Java Control Panel.) I'm using its information for the International Space Station and Hubble Space Telescope, interpolating when necessary. 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 -3.8 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.

Missions to and from the International Space Station can change its orbit. The only launch during the time period to the ISS is that of a Progress cargo craft on July 23

HST, 12 July 2020

Time	Position	Elevation
10:32 p.m.	230°	20°
10:33	211	27
10:34	184	31

Vanishes into Earth's shadow

HST, 13 July 2020

Time	Position	Elevation
10:21 p.m.	231°	19°
10:22	213	26
10:23	186	26

Vanishes into Earth's shadow

ISS, 14 July 2020

Time	Position	Elevation
5:56 a.m.	312°	23°
5:57	313	43
5:58	104	88
5:59	133	42
6:00	133	22

ISS, 14 July 2020

Time	Position	Elevation
10:36 p.m.	256°	20°
10:37	274	33
10:38	322	45
10:39	9	33
10:40	27	20

ISS, 15 July 2020

Time	Position	Elevation
5:08 a.m.	332°	20°
5:09	349	34
5:10	38	47
5:11	88	34
5:12	106	20

ISS, 15 July 2020

Time	Position	Elevation
9:49 p.m.	229°	22°
9:50	232	42
9:51	329	85
9:52	43	43
9:53	46	23

ISS, 17 July 2020

Time	Position	Elevation
5:09 a.m.	292°	20°
5:10	274	34
5:11	226	46
5:12	178	34
5:13	161	20

ISS, 2 August 2020

Time	Position	Elevation
10:06 p.m.	314°	23°
10:07	317	43
10:08:28	63	85
10:09:08	125	54

ISS, 3 August 2020

Time	Position	Elevation
9:19 p.m.	333°	20°
9:20	351	33
9:21	38	45
9:22	85	33
9:23	104	20

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 International Space station at 5:13 a.m. on July 27, you would measure two fist-widths east of due south, then two fist-widths above the horizon.

All times are rounded off to the nearest minute except for times when the satellite enters or leaves the shadow of the Earth. The highest elevation shown for each viewing opportunity is the actual maximum elevation for that appearance.

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>.

Highlights: July 15, 2:00 p.m.: NASA Science Live: Perseverance Mars Rover & the Search for Ancient Life".

July 23, 9:00 a.m.: Coverage of the launch of Progress 76 cargo craft from Baikonur, Kazakhstan to the ISS. (Actual launch is 9:26 a.m.) 12:00 noon: Coverage of the rendezvous and docking of Progress 76 with the ISS. (Actual docking is 12:47 p.m.)

There will certainly be coverage of the launch of Perseverance on July 30, but it's not on the schedule yet.

NASA also has a weekly podcast, This Week @ NASA, which you can watch online at <https://www.youtube.com/playlist?list=PL1D946ACB21752C0E>

. You can also get the most recent episodes at NASA.gov.

Calendar of Events

Sometime in 2020: 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>.

July 11: Oklahoma Space Alliance meeting, 2:00 p.m., via Zoom.

July 12: the asteroid Pallas is at opposition and is magnitude 9.6.

July 14: Jupiter is at opposition

July 14: United Arab Emirates launch the Mars Hope, aka as Al-Amal or the Emirates Mars Mission, from the Mohammed bin Rashid Space Center in Dubai. For more information, visit https://en.wikipedia.org/wiki/Hope_Mars_Mission.

July 15: Pluto is at opposition but is only magnitude 14.3.

July 20: Saturn is at opposition.

July 20: 51st anniversary of *Apollo 11* moon landing.

July 22: Mercury is at greatest western elongation, 20.1 degrees from the Sun (hence can be seen before sunrise).

July 23: Launch of Tianwen-1 (formerly Huoxing-1), the Mars Global Remote Sensing Orbiter, Lander and Small Rover by China. For more information, see https://en.wikipedia.org/wiki/Mars_Global_Remote_Sensing_Orbiter_and_Small_Rover. (China really needs to work out an acronym for this.)

July 27: Peak of Delta Aquariid meteor shower.

July 30 [Moved from July 17]: Launch of *Perseverance* (formerly Mars 2020) space rover and the helicopter *Ingenuity*, which will arrive on Mars in February 2021. For more information, see https://en.wikipedia.org/wiki/Mars_2020 or <https://mars.jpl.nasa.gov/mars2020>

August 8: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

August 12: Peak of Perseid meteor shower.

August 13: Venus is in greatest western elongation 45.8 degrees from the Sun (hence is visible before sunrise.)

August 17: Mercury is in superior conjunction with the Sun.
September 11: Neptune is at opposition.
Last quarter of 2020 or early 2021 (postponed from July): Maiden flight of Ariane 6 from Kourou, French Guiana.
October 1: Mercury is at greatest eastern elongation, 25.8 degrees from the Sun (hence can be seen after sunset).
October 13: Mars is at opposition, 39 million miles from Earth.
October 20 – 21: Peak of Orionid meteor shower.
October 23: Mercury is in inferior conjunction with respect to the Sun.
October 30: Uranus is at opposition.
November 10: Mercury is at greatest western elongation, 19.1 degrees from the Sun (hence can be seen before sunrise).
December: Test flights begin for India's Gaganyaan program, which will eventually launch people into orbit.
December (Postponed from December 2019): Launch of China's Chang'e 5 lunar sample return mission. This will be the first mission of this type since 1976. For more information, see https://en.wikipedia.org/wiki/Chang%27e_5
December 13-14: Peak of Geminid meteor shower.
December 14: Total eclipse of the Sun visible in southern Chile and Argentina, Kiribati and a long path across the wastes of the southern Pacific and Atlantic Oceans.
December 19: Mercury is in superior conjunction with the Sun.
December 21: Great conjunction between Jupiter and Saturn. The two planets will be separated by six minutes of arc.
December 22: Peak of Ursid meteor shower.
Sometime in 2021: Hope, aka Emirates Mars Mission, arrives at Mars (see July 2010).
Sometime in 2021: China launches the first module of their space station.
Sometime in 2021 [tentative]: India and Japan launch 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.
Sometime in 2021 [Moved from 2020]: ALINA, the Autonomous Landing and Navigation Module will be launched aboard a Falcon Block 5, and land near the Apollo 17 landing site in the Taurus-Littrow valley. It will carry two Audi lunar rovers which will try to locate Apollo 17's Lunar Rover. For more information, see <https://ptscientists.com/products/alina>.
January 3, 2021: Peak of Quadrantid meteor shower.
January 23, 2021: Mercury is at greatest eastern elongation, 18.6 degrees from the Sun (so can be seen after sunset).
January 23, 2021: Saturn is in conjunction with the Sun.
January 28, 2021: Jupiter is in conjunction with the Sun.
January 31 – February 9, 2021: 50th anniversary of Apollo 14.
February 2021: Maiden flight of KSLV-II (aka Nuri), the first South Korean indigenous orbital launch vehicle.
February 8, 2021: Mercury is at inferior conjunction with the Sun,
February 18, 2021: Mars rover Perseverance (formerly Mars 2020) lands at Jezero Crater on Mars. It will be carrying the Mars Helicopter Scout aka Ingenuity, which will deploy in two or three months.
March 6, 2021: Mercury is at greatest elongation, 27.3 degrees west of the Sun (hence can be seen before sunrise).
March 10, 2021: Neptune is in conjunction with the Sun.
March 26, 2021: Venus is at superior conjunction with the Sun.
April 2021: Launch of the James Webb Space Telescope. For more information, see https://en.wikipedia.org/wiki/James_Webb_Space_Telescope
April 18, 2021: Mercury is at superior conjunction with the Sun.
April 22, 2021: Peak of Lyrid meteor shower.
April 30, 2021: Uranus is in conjunction with the Sun.
May 26, 2021: Total eclipse of the Moon, visible from all the Pacific Ocean and lands on its rim. In Oklahoma, totality will be occurring just before moonset
June 10, 2021: Annular eclipse of the Sun. The eclipse passes through the Arctic from Russia just north of Kamchatka, almost to the North Pole, back through northwestern Greenland, Baffin Island, and Hudson Bay. Until terminating in central Ontario north of Lake Superior. In other words, few people will be able to see the annular eclipse, though a partial eclipse will be visible in the northeastern United States, and eastern and central Canada.
July 2021: 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_\(rocket\)](https://en.wikipedia.org/wiki/Vulcan_(rocket)) and https://en.wikipedia.org/wiki/Astrobotic_Technology#Peregrine_lander.
July 26 – August 7, 2021: 50th Anniversary of Apollo 15.

August 2021: Launch of the IXPE X-Ray Telescope by Falcon 9. For more information, see <https://en.wikipedia.org/wiki/IXPE>.

August 2, 2021: Saturn is at opposition.

August 19, 2021: Jupiter is at opposition.

September 2021: First Dream Chaser cargo mission to the ISS.

October 16 – November 5, 2021: Launch window for Lucy, a mission to explore Jupiter's Trojan Asteroids. See [https://en.wikipedia.org/wiki/Lucy_\(spacecraft\)](https://en.wikipedia.org/wiki/Lucy_(spacecraft)) for details.

October 2021: 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>.

October 1, 2021: Launch of the Luna 25 lunar lander, the first mission of Russia's Luna-Glob lunar exploration mission. For more information, visit en.wikipedia.org/wiki/Luna_25 and en.wikipedia.org/wiki/Luna-Glob.

November 2021: [Moved from 2020] Launch of Artemis 1 the first launch of the Space Launch System. On this 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 NearEarth Asteroid Scout cubesat (https://en.wikipedia.org/wiki/Near-Earth_Asteroid_Scout) and a bunch of other satellites.

December 2021 [VERY tentative]: India launches its first manned orbital flight Gaganyaan-3.

Sometime in 2022: SpaceX plans to launch a human crew around the Moon. [This is speculative, reflected by this mission being postponed from 2018.]

April 16 – 27, 2022: 50th anniversary of Apollo 16.

May 22 - June 10, 2022: Launch window for JUICE, the Jupiter Icy Moons Explorer, by the European Space Agency. The JUICE web site is <https://sci.esa.int/web/juice>.

June 2022: First crewed launch of an Orion space capsule.

June 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>.

July 2022 (postponed from December 2020): Launch of the Korea Pathfinder Lunar Orbiter (KPLLO) and lunar impactor from Naro Space Center in South Korea. For more information, see https://en.wikipedia.org/wiki/Korea_Pathfinder_Lunar_Orbiter.

July 2022: Launch of Psyche, which will orbit a large metallic asteroid also named Psyche. For more information, visit [https://en.wikipedia.org/wiki/Psyche_\(spacecraft\)](https://en.wikipedia.org/wiki/Psyche_(spacecraft)).

August - October 2022 [postponed from 2020]: ESA launches the ExoMars Mars Rover, which has been christened Rosalind Franklin, and the Exomars 2020 surface platform. For more information, visit <https://en.wikipedia.org/wiki/ExoMars>

September 26, 2022: Jupiter is at opposition.

December 2022 (Tentative): Launch of the first module of the Gateway Lunar Orbiter Platform.

December 7 – 19, 2022: 50th anniversary of Apollo 17. This, to date, is the last manned mission to the Moon.

Sometime in 2023: OSIRIS-REx returns samples from Asteroid Bennu.

Sometime in 2023 (tentative): 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.

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

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

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.

Late 2023: Launch of NASA's VIPER lunar rover, which will hunt for ice near the Moon's South Pole.

Sometime in 2024: India launches its Mangalayaan-2 Mars mission, which includes an orbiter, lander and rover.

Sometime in 2024: Planned date of Artemis 3, which will land astronauts 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.

September 2024: Launch of Japan's Martian Moons Exploration, which includes a Phobos lander.

December 19, 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: First crewed flight of Russia's Orel (formerly called Federatsiya).

December 2025: BepiColombo arrives at Mercury orbit.

April 2026: Launch of Dragonfly to Titan.

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

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, 2020 (Area Code 405)

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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 phone is 202-424-2899 (new as of May 2019). 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]

OKLAHOMA SPACE ALLIANCE
A Chapter of the National Space Society
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Please enroll me as a member of Oklahoma Space Alliance. Enclosed is:

_____ \$10.00 for Membership. (This allows full voting privileges but covers only your own newsletter expense.)

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National Space Society has a special \$20 introductory rate for new members. Regular membership rates are \$52, Student memberships are \$36, Senior \$42. Part of the cost is for the magazine, *Ad Astra*. If you choose to receive the magazine digitally, memberships are \$40 for regular, \$24 for students and \$30 for seniors. Mail to: National Space Society, PO Box 98106, Washington, DC 20090, or join at www.nss.org/membership. (Brochures are at the bottom with the special rate.) Be sure to ask them to credit your membership to Oklahoma Space Alliance.

To join the Mars Society, visit www.marssociety.org. One-year memberships are \$50.00; student and senior memberships are \$25, and Family memberships are \$100.00. Their address is Mars Society, 11111 W. 8th Ave, Unit A, Lakewood, CO 80215.

Do you want to be on the Political Action Network?

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