

# OKLAHOMA SPACE ALLIANCE

## OUTREACH - September 2022

**102 W. Linn #1, Norman, OK 73069**

Oklahoma Space Alliance will meet at the  
McMurray residence at 2:00 p.m.  
on September 10, details inside



Cartwheel Galaxy, or What a Galactic Collision Can Do. (Webb telescope image from NASA)

## OKLAHOMA SPACE ALLIANCE OUTREACH

### September 2022

#### September Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, September 10, 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 have this meeting on Zoom for those who cannot attend in person: To join the meeting, go to <https://tinyurl.com/y2qtab28>. If the link doesn't work, call Clifford McMurray, President 405-329-4326 (H), 405-863-6173 (C) (e-mail [cliffmcmurray@hotmail.com](mailto:cliffmcmurray@hotmail.com)) or Syd Henderson at 405-365-8983 (e-mail [sydh@ou.edu](mailto:sydh@ou.edu)) and we will send you updated information.

#### Saturday September 10, 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.
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
  - a. Review OSA treasurer's report
  - b. Minutes of April meeting
  - c. Chapters Assembly (Syd)
  - d. Presentations from ISDC
5. Video (to be announced)
6. Chat

#### Minutes of August 2022 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met August 13, 2022, at the McMurray's house in Norman, Oklahoma. Attending were Clifford and Claire McMurray. Adam Hemphill, Tim Scott, Dave Sheely, and Syd Henderson. Steve Galpin attended by Zoom. OSA President Clifford (Kip) 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/Update2208.pdf> so I'll cover the details that aren't covered there.

We started late due to complications with accessing Update on the laptop. I finally suggested that we use the version that appears on the OSA website, and that worked, although it was the unrevised version. There was only one change between the two versions.

The *Wentian* module to the Chinese space station *Tiangong* has a five-meter-long robot arm. [The upcoming *Mengtian* will as well. The *Tianhe* core module has a 10.2-meter (34-foot) robot arm, so *Tiangong* is well supplied with robot arms.]

We watched the launch of the Long March 5B rocket carrying the *Wentian* module. The first stage couldn't be restarted so reentry was uncontrolled. Although it was supposed to come down in an empty part of the Indian Ocean, it actually landed in the Sulu Sea near the island of Palawan in the Philippines. [This is the long thin island in the southwestern Philippines, home to a million people.] The debris apparently didn't hit land. We watched video of the reentry.

The Long March 9 is supposed to launch by 2030, so why is a report that it will be a reusable launch vehicle in 2035.

Impulse Space is a startup that will be using 3-D printed rockets built by Relativity Space. Several of these have already been built, and the first launch of Terran 1, as it is called, will be later this year. A future version, Terran R, will go to Mars in 2024.

One of the women on *Blue Origin's* August 4 launch, Vanessa O'Brien, completed the Explorers' extreme trifecta: She has ascended Mount Everest and descended to the bottom of the Challenger Deep, the deepest spot in the ocean. She is the first woman to complete the trifecta and the second person overall. [Victor Viscovo, who flew on *Blue Origin* in June was the first.]

*This Week in Space* had a tribute to Nichelle Nichols who died July 30 at age 89. She is best known as Lieutenant Uhura on *Star Trek*, but she also was a space activist, working for NASA recruiting women and minorities (including Sally Ride, Guion Bluford, Judith Resnik and Ronald McNair. Nichols also served on the NSS Board of Governors for many years.

We have \$807.41 in bank account and \$267 in cash.

Minutes by OSA Secretary Syd Henderson

## Minutes of July Meeting

Oklahoma Space Alliance met July 9, 2022, at the McMurray's house in Norman, Oklahoma. Attending were Clifford and Claire McMurray. Mark Deaver, Adam Hemphill, John Northcutt, Dave Sheely, and Syd Henderson. Robin Scott attended via Zoom. This was Mark's first meeting. OSA President Clifford (Kip) 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/Update2207.pdf> so I'll cover the details that aren't covered there.

China is making serious plans about sending people to the Moon. They will have an orbiter, lander and ascent vehicle. Kip compares it to the Apollo lander and return.

We watched a video on the launch of CAPSTONE. The company that's doing this is also planning CubeSat missions to Venus and Mars.

We watched a detailed video of BepiColombo's recent flyby of Mercury. Several flybys are required for BepiColombo to settle into Mercury orbit due to Mercury's small mass. [Putting a spacecraft into Mercury orbit also involves increasing its velocity to match Mercury. This is actually more difficult than sending a spacecraft to the outer solar system.] This flyby took BepiColombo 125 miles above the surface of Mercury.

There are repeated proposals to create a Space National Guard as part of the United States Space Force. [We already have an Army National Guard and Air National Guard, and members could transfer from them to the Space National Guard.] Air National Guardsmen used to support the Air Force Space Command. If they aren't transferred to the Space Force, they may have to transfer to new specialties within the AFNG. States affected include California, Arizona, Colorado, Wyoming, Ohio, New York, Florida, and Alaska. (Alabama doesn't have a Space Force branch for them to transfer to.)

We looked at an article about the James Webb Space Telescope being hit by a meteoroid. This was accompanied by a video on meteoroids hitting the solar panels of the Hubble Space Telescope. (Some panels were brought back) and the hazards they present to all spacecraft including the JWST.

We went through a Space News article on Orbit Fab's contract for refueling satellites, including military satellites that fall under Space Force's.

We had discussion on the Russo-Ukraine War and the Western response

We went through an article on Intersatellite Laser Communication. [Which, if I remember, is how SkyNet began.]

--Minutes by OSA Secretary Syd Henderson

## Space News

The cover picture of this newsletter is an infrared image taken by the James Webb Space Telescope of the Cartwheel Galaxy, which has a large ring tens of thousands of light-years from its core. The image also shows spokes connecting the ring to the center. This structure was caused by a smaller galaxy that passed through the galaxy's core 300 million years ago, producing a shock wave and disrupting the spiral arms of the Cartwheel Galaxy. The colliding galaxy still exists but has travelled off the upper side of the picture. The two galaxies to the left in the picture are part of the same group. The small spiral to the right is not.

The structure of the galaxy on the upper left also shows clearly in the MIRI image, but the one to the lower left is reduced to its core.

In other Webb news, it has successfully directly imaged its first exoplanet, HIP 65426b. This planet is between six to twelve times the mass of Jupiter; that upper limit is almost the mass of a brown dwarf. The planet is 385 light-years from Earth, which indicates the power of both the JWST and the Very Large Telescope in Chile.

Webb should be able to image planets the mass of Neptune and Uranus orbiting M type red dwarfs at distances of 100 – 200 au., and Saturn-mass objects at distances of 10 au. from a red dwarf. That is identical to the distance of Saturn from our Sun. HIP 65426 b is 100 au. from its star, so that fits, but the star is type A2, so is more like Sirius A.

It is very likely that Webb can directly image any Earth size planet in the habitable zone of Alpha Centauri A. Since directly imaging a planet means blocking the light of its star, Webb would have to block the light of Alpha Centauri B as well. (Proxima is distant enough from them that it's not a factor.)

It also detected carbon dioxide in the atmosphere of the hot Jupiter WASP 39b as it earlier detected water vapor in the spectrum of WASP 96b (also hot but half the mass of Jupiter.) I don't think that the discovery of either is a surprise since they are common in the Solar System (as are methane, ammonia and nitrogen).

None of these exoplanets are discoveries by the JWST. HIP 65426b was discovered in 2017 by the Very Large Telescope in Chile. (The HIP indicates the star is in the Hipparcos catalog). WASP is the acronym for the Wide-Angle Search for Planets, which discovered WASP 39b and 86b.

Webb has also found its first brown dwarf, which rejoices in the name GLASS-JWST-BD-1. This one is more than 2000 light-years away and has a mass thirty times that of Jupiter. It is also surprisingly cool with a surface temperature of around 600°K. which translates by coincidence to 620° F. It is estimated to be some five billion years old. It's not the coolest brown dwarf, but the candidates for that are at the borderline for being planets and it's not certain which side of the boundary particular objects lie on.

Another brown dwarf observed by Webb, VHS 1256-1257 b, is only 72 light-years away and is much hotter. In fact, it appears to have silicate clouds. This one is only 19 times as massive as Jupiter. The atmosphere also contains water, methane, carbon monoxide, carbon dioxide, sodium and potassium.

Brown dwarfs are called "failed stars" in that they cannot fuse protons to make helium. They may be able to fuse deuterium together or combine fuse lithium with deuterium or even protons. My guess is that the first of these brown dwarfs has long since ceased any kind of fusion. The second may still do a little, but it's pretty borderline.

Webb also took spectacular infrared images of the Phantom Galaxy (Messier 74). Unfortunately, the copier was eating paper, so I'll have to content myself with a link. This one: <https://scitechdaily.com/spectacular-image-of-heart-of-phantom-galaxy-showcases-webbs-power/> gives you a comparison of images taken by Webb in infrared and the Hubble Space Telescope in visible light. Alternatively, [https://en.wikipedia.org/wiki/Messier\\_74](https://en.wikipedia.org/wiki/Messier_74) shows you how it looks from an Earth-based telescope and from the Webb.

The much-anticipated launch of *Artemis 1* now looks like it will be delayed another two weeks due to a fuel leak in the hydrogen tank. Since it will miss its September 6 launch window, it is delayed at least to the September 16 – October 4 launch window. If that is missed, the next launch window is October 17 – October 31.

This is the second launch delay: The August 29 launch window was missed due to a faulty temperature sensor which caused one of the engines on the core stage to not cool down properly. That problem diagnosed, NASA decided to try again on September 3, which is when the fuel leak popped up. Actually, two fuel

leaks, one on August 29 that was fixed and a bigger one on September 3 that they were unable to fix in time for launch. “The leak occurred after a brief “inadvertent” overpressurization of the fuel line that was three times the acceptable pressure, said Mike Sarafin, NASA’s Artemis 1 mission manager.” [Space.com].

Of course, the question of what happens to *Artemis 2*’s launch date comes to mind. I think that if the leak problem is resolved by the end of October, then probably nothing, since *Artemis 2* isn’t until May of 2024, which means we have a lot of lead time. *Artemis 1* being the first of a new launch vehicle, some minor delays are to be expected, and it’s certainly better to take the time to make sure the rocket is safe to launch than to have it blow up and delay return to the Moon for years.

*Artemis 1* will be carrying a bunch of Cubesats, most of which will be going either into Lunar orbit or heliocentric orbit. It will also carry three mannequins, NASA’s Snoopy dog, and a Shawn the Sheep doll after the Aardman Claymation character. I was thinking Gromit, but he and Wallace have already been to the Moon (“A Grand Day Out.”)

On August 30, the Sun gave off a large coronal mass ejection, just in time to hit the European Space Agency’s Solar Orbiter as it was passing by Venus for a gravity assist. The spacecraft, which is hardened against the Sun’s more violent activities, seems completely undamaged.

The ESA is planning a dedicated pair of solar weather satellites called *Vigil* for the mid-2020s to detect violent solar activity and give us fair warning. It is difficult from Earth to see a coronal mass ejection if it is heading straight toward us. The *Vigil* mission will send one satellite each to the Earth-Sun L4 and L5 points so they can give us fair warning. Although it would take sixteen minutes to warn us (because it takes eight minutes for light to go from the Sun to the spacecraft and eight more for radio signals to go from the satellites to Earth), that is still enough for several days warning. The notorious Carrington Event of September 1-2, 1859, was a coronal mass ejection and had really flamboyant effects on telegraphs. A replay could cause blackouts and computer havoc of a scale not yet seen.

Data from *InSight* indicates that if we want to utilize Martian ice in building a Mars colony, we may want to avoid the Martian tropics. *InSight* is designed to detect seismic waves, and those change velocity going through ice. They seem to encounter few traces of ice at all in the tropics, though they have been found at higher latitudes. In fact, there is no evidence of water or ice down to 1000 feet below the probe. This contrasts with, say, *Phoenix*, which landed practically on top of a patch of ice. The difference is that *InSight* is about four degrees north of the Martian equator, and *Phoenix* is at latitude 68° N, which is within the Martian Arctic and close to the Martian North Polar ice cap which contain both water ice, and, when it is cold enough, frozen carbon dioxide.

It’s taken two years to confirm and publish, but a team of astronomers have discovered the first of what is presumably a new population of asteroids (“The discovery and characterization of a kilometre sized asteroid inside the orbit of Venus,” <https://academic.oup.com/mnras/advance-article/doi/10.1093/mnras/slac089/6665933?login=false>). The asteroid is named 594913 ‘Aylo’chaxnim, which means “Venus Girl” in the native language, Luiseño, of the Pauma. (The “x” is pronounced like k, apparently. The accent is on the “lo”). Paloma Observatory from which the Asteroid was observed is located on Pauma land in southern California.

As the article implies, ‘Aylo’chaxnim’s orbit lies entirely within the orbit of Venus, never going more than 0.65 au from the Sun. It is the first asteroid ever discovered with such a close orbit. Despite the title of the paper, it may be two kilometers in diameter. Its orbit also appears to be in a 3:2 resonance with Venus, which makes a collision unlikely for the next few million years, after which it will probably be perturbed into some other orbit.

Families of asteroids are often named after their first discovered member The Amor asteroids come close to but do not cross Earth’s orbit, Apollo and Aten, asteroids do cross Earth’s orbit, and Atira asteroids orbit within Earth’s orbit but not completely within Venus’s. Thus, asteroids which do not orbit beyond Venus will probably called ‘Aylo’chaxnim asteroids, or maybe Venus Girls. However, when the possibility of such objects was predicted around 2012, they were called Vatira asteroids (i.e., a portmanteau of Venus and Atira), so you may see that some places.

By the way, we already have a name for asteroids whose orbits lie within the orbit of Mercury: the term is “Vulcanoids,” which I hope sticks since it refers to the hypothetical and nonexistent planet Vulcan which was supposed to orbit within Mercury’s orbit. However, if any are discovered, tis group would probably be named after the first one found. If Vulcanoids exist, they are expected to be very rare and very difficult to detect given their proximity to the Sun.

Incidentally, the team wanted to use the Luiseño name for “Venus’ daughter,” but they decided it was too long.

## Sky Viewing

There is a **Total Eclipse of the Moon** on November 8, which will be before I mail out the next *Outreach*, so I'd better report it now. This is the second total eclipse visible in Oklahoma this year, but since the first was ruined by clouds until it was past totality, I'm looking forward to this one. Unlike last May's eclipse, this one is in the morning before dawn. Partial phase begins at 3:0, etc., 9 a.m., with the Moon being totally eclipsed from 4:17 to 5:42 a.m., and the partial eclipse ends at 6:49 a.m. Although all this takes place while the Moon is above the horizon, it will be awfully low in the west by the time the partial phase ends. The eclipse actually ends before the Moon leaves the Earth's penumbra.

We have three meteor showers between this newsletter and the next! The **Orionid Meteor Shower** peaks on the night of October 20 -21 with a peak of maybe 20 meteors per hour. The radiant (the point the meteors seem to come from) is about ten degrees northeast of Betelgeuse in the direction, so it's easy to find. (If you continue in this direction, you reach Castor and Pollux in Gemini.) The Orionids are one of the two meteor showers spawned by Halley's Comet. The other is the Eta Aquariids in May. As for Halley's Comet itself, it is currently located 3.2 billion miles from Earth (about as far as Neptune) and is a few degrees below Hydra's head shining at a sparkling magnitude 26. I suppose the James Webb Space Telescope might be able to see it.

The other two showers are the **Northern and Southern Taurids**. These might be very active this year. Both are children of Encke's Comet<sup>1</sup>, which has an orbital period of 3.3 years. It's actually in a 7-2 resonance with Jupiter, which means so is the debris, and parts of the debris are concentrated by this resonance. We hit one of those concentrations this October and November. The Southern swarm peaks on October 10 and the Northern on November 12, but they are unusually spread out and are visible for a month on either side of those dates. They have a tendency to produce fireballs. In off years, these showers only produce five meteors per hour, but there should be many more this year. The radiant, of course, is in Taurus, the home of the Pleiades and Hyades (and Aldebaran), and the constellation northwest of Orion. The radiant of the South Taurids is southeast of the Pleiades, and the radiant of the North Taurids is a couple degrees south of the Pleiades.

**Mercury** is currently lost in the sunset as it approaches inferior conjunction with the Sun on September 23. However, in October it will have its best morning appearance. On October 5 it will be at magnitude 0 and about seven degrees above the horizon at 45 minutes before sunrise. By greatest elongation on October 8, it will be magnitude -0.4 and more like 10-12 degrees above the horizon. It will reach magnitude -1.1 by October 24 but will also be low in the sky by then. That is unfortunate because the Moon will occult Mercury as seen from Oklahoma.

**Venus** is barely up before the Sun so it's a challenge to see. This will only get worse since it is approaching superior conjunction with the Sun on October 22. We'll start to see it in evening in December.

**Mars**, on the other hand, is becoming more and more visible. Currently it's rising about 11:00 p.m. and is magnitude -0.2. This makes it the brightest object in Taurus, where it is not far above Aldebaran. Mars is getting brighter, increasing to magnitude -0.6 by the end of September and -1.1 by the end of October. Mars will be at opposition on December 1, at which time it will be magnitude -1.9. Not nearly as bright as in 2020, but still respectable.

Mars remains in Taurus for the rest of the year and into next March through the wonder of retrograde motion.

With Venus all but invisible, **Jupiter** is by far the brightest planet in the night sky. It is currently magnitude -2.8, brighter than any star and also the Tiangong space station, but the ISS gets a bit brighter. In fact, Jupiter is at opposition on September 26, at which point it will be magnitude -2.9 and stay that bright all the way through October. Jupiter is in Pisces if you want to find that constellation. It is also near the head of Cetus the Whale. (Jupiter was actually in Cetus in July and August. The ecliptic almost touches a corner of Cetus, and if a planet is a half-degree or so south of the ecliptic, it can find itself in that constellation.)

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<sup>1</sup> Technically the North Taurids originate from asteroid 2004 TG<sub>10</sub>, but that is believed to be a fragment of Encke's comet.

**Saturn** is just past its August 14 opposition and is still near its maximum brightness at magnitude 0.3. Although that's a lot dimmer than Jupiter, it is also in Capricornus, the least conspicuous of the Zodiacal constellation. In fact, the nearest bright star, Fomalhaut is quite a bit south of it and is in the otherwise inconspicuous Piscis Austrinus.

Of the other major planets, **Uranus** is magnitude 5.7 (it's always about that magnitude) and is a third of the way from Mars to Jupiter. The constellation is Aries, where it will be for the next year. **Neptune** is magnitude 7.8 and is about ten degrees west of Jupiter, almost dead on the boundary of Pisces and Aquarius. It will be at opposition on September 16, but its distance only allows it to brighten to magnitude 7.7. It's also in retrograde motion which is carrying it out of Pisces and back to Aquarius. It won't be back into Pisces until late winter.

### Viewing Opportunities for Satellites (September 10 – October 14, 2022)

You can get sighting information at [www.heavens-above.com](http://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 [skycastle.com/observing/almanac](http://skycastle.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 -2.3 after the addition of the Wentian module in July. We can expect it to get even brighter after the Mengtian module is added in October.

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 and *Tiangong* can change their orbits. The Russians are launching a Soyuz to the ISS on September 21, and SpaceX is launching Crew-5 on October 3. (The Soyuz is carrying one NASA astronaut and the Dragon one cosmonaut as part of an exchange arrangement between Russia and the United States. The Chinese are launching the Mengtian laboratory cabin module to *Tiangong* sometime in October.

The information below is from Heavens Above. There are no decent passes for the Hubble Space Telescope this month.

#### ISS 9/9/22 mag. -3.2

Time	Position	Elevation
6:17 a.m.	320°	10°
6:20	40	58
6:23	121	10

#### ISS 9/11/22 mag. -3.3

Time	Position	Elevation
6:17 a.m.	295°	13°
6:20	227	38
6:23	157	10

#### ISS 9/14/22 mag. -3.6

Time	Position	Elevation
8:31 p.m.	212°	10°
8:35	134	53
8:37	60	15

#### ISS 9/16/22 mag. -2.6

Time	Position	Elevation
8:31 p.m.	247°	10*°
8:34	322	44
8:38	36	10

\*Passes very close to Arcturus

#### Tiangong 9/9/22 mag. -2.3

Time	Position	Elevation
Appears from Earth's shadow		
5:49:57 a.m.	233°	68°
5:50:17	155	85
5:53	66	10

## Tiangong 9/19/22 mag. -1.2

Time	Position	Elevation
6:24 a.m.	283°	17°
6:26	345	37
6:29	55	10

## Tiangong 9/25/22 mag. -1.3

Time	Position	Elevation
6:45 a.m.	303°	10°
6:48	18	45
6:51	92	10

## Tiangong 9/27/22 mag. -2.0

Time	Position	Elevation
Appears from Earth's shadow		
6:21:07 a.m.	301°	30°
6:23:08	22	71
6:26	108	10

## ISS 10/4/22 mag. -3.8

Time	Position	Elevation
8:31 p.m.	310°	10
8:34:21	224	77
8:35:05	150	51

Vanishes into Earth's shadow°

## ISS 10/7/22 mag. -2.5

Time	Position	Elevation
7:42 p.m.	299°	10°*
7:45	227	42
7:48	154	10

\*Passes very close to Arcturus

## Tiangong 10/8/22 mag. -2.0

Time	Position	Elevation
7:42 p.m.	230°	10°
7:45	152	55
7:48	75	14

## Tiangong 10/9/22 mag. -1.5

Time	Position	Elevation
8:17 p.m.	265°	10°
8:20:25	341	48
8:21:23	33	34

## Tiangong 10/11/22 mag. -0.9

Time	Position	Elevation
7:52 p.m.	278°	10°*
7:55	346	34
7:57	47	15

\*Passes very close to Arcturus

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. So, to watch Tiangong appear on September 27, measure three fist-widths north of due west, then three-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>.

Times below are Central Daylight Time.

If the Artemis launch is delayed, it will certainly be covered. Similarly for the Soyuz arrival at the Space Station on September 21 and the SpaceX Crew 5 launch on October 3. Outside of those, the most important are:

September 12, 11:00 a.m.: 60<sup>th</sup> anniversary of John Kennedy's famous Moon speech.

September 26, 5:00 p.m.: Live coverage begins for the DART suicidal impact test with the asteroid Dimorphos.



## Calendar of Events

Second half of: Launch of *Eris*, the first Australian rocket to launch an Australian payload. *Eris* is the launch vehicle for Gilmour Space. For more information, visit [en.wikipedia.org/wiki/Gilmour\\_Space\\_Technologies#Eris](https://en.wikipedia.org/wiki/Gilmour_Space_Technologies#Eris).

Second half of 2022: first test of flight of the full-scale version of Perigee Aerospace (South Korea) *Blue Whale 1* from Whalers Way in Australia.

Third quarter of 2022: Maiden flight of Taiwan's Hapith V from Whalers Way in Australia. For more information, see [https://en.wikipedia.org/wiki/TiSPACE#HAPITH\\_I](https://en.wikipedia.org/wiki/TiSPACE#HAPITH_I).

Third quarter of 2022: Launch of first commercial small satellite to Mars, built by the Polish company SatRevolution and air-launched by Virgin Orbit via *LauncherOne* and the plane *Cosmic Girl*.

Third Quarter of 2022: First flight test of SpaceX Starship spacecraft, to be launched from SpaceX Starbase in Boca Chica, Texas. This will complete three-quarters of an orbit.

Sometime in September: Launch of *LauncherOne* from Mojave, carrying the ELaNa 46 mission. This is a Virgin Orbit flight carried by a plane named *Cosmic Girl*.

Sometime in September: Launch of *LauncherOne* from Spaceport Cornwall, England. This launch will place six satellites in low-Earth orbit, including the first for Oman. This is a Virgin Orbit flight carried by a plane named *Cosmic Girl*. [This is not a duplicate: Orbit has two launches this month.]

September 9: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See [www.okcastroclub.com](http://www.okcastroclub.com) for details.

September 10: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence. Meeting information will be posted at <http://osa.nss.org>.

September 11: Second launch attempt of *Firefly Alpha*.

September 16 – October 4: Next launch windows for *Artemis 1*.

September 21: Launch of Soyuz-2.1a to the ISS, carrying cosmonauts Sergey Prokopyev and Dmitry Petelin, and NASA astronaut Francisco Rubio.

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

September 23 – October 1: Okie-Tex Star Party, Camp Billy Joe, Kenton, Oklahoma. Hosted by the Oklahoma City Astronomy Club. For more information, visit [nightsky.jpl.nasa.gov/event-view.cfm?Event\\_ID=122794](http://nightsky.jpl.nasa.gov/event-view.cfm?Event_ID=122794) or [www.okcastroclub.com](http://www.okcastroclub.com).

September 26: Jupiter is at opposition.

September 26 – October 1: DART will impact with the asteroid Dimorphos in an effort to change its orbit. [See October 2024 for the follow-up mission, *Hera*.

Late September: 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](https://en.wikipedia.org/wiki/Luna_25) and [en.wikipedia.org/wiki/Luna-Glob](https://en.wikipedia.org/wiki/Luna-Glob).

October: [Moved from August]: Launch of *Mengtian*, the second laboratory module to the *Tiangong* space station.

October 3, 11:45 a.m.: SpaceX Crew 5 mission to the ISS. This launch will carry two, NASA astronauts Commander Nicole Mann and Pilot Josh Cassada, JAXA astronaut Koichi Wakata and Roscosmos cosmonaut Anna Kikina to the ISS where they will stay till the end of March.

October 8: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence. Meeting information will be posted at <http://osa.nss.org>.

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

October 14: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See [www.okcastroclub.com](http://www.okcastroclub.com) for details.

October 17 – October 31: Launch windows for *Artemis 1* if it is further delayed.

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.

Early November: 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. For information on that, see [en.wikipedia.org/wiki/Emirates\\_Lunar\\_Mission](https://en.wikipedia.org/wiki/Emirates_Lunar_Mission).

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 11: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See [www.ok-castroclub.com](http://www.ok-castroclub.com) for details.

November 12: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence. Meeting information will be posted at <http://osa.nss.org>.

November 17: Peak of Leonid meteor shower.

December [Moved from November]: Launch of *Polaris Dawn* flight carrying four civilians into space, led by Jared Isaacman.

December: Launch of the *Peregrine* lunar lander by ULA's Vulcan Centaur for Astrobiotic Technology. This is the maiden flight for Vulcan Centaur.

December: First crewed launch of *Boeing Starliner-1* to the ISS.

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

December 5: Launch of SWOT, the Surface Water and Ocean Topography mission, which will conduct the first global survey of the Earth's surface water and measure how they change over time.

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 9: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See [www.ok-castroclub.com](http://www.ok-castroclub.com) for details.

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

December 22: Peak of Ursid meteor shower.

Sometime in 2023: [Postponed from 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](https://en.wikipedia.org/wiki/Smart_Lander_for_Investigating_Moon) and [https://en.wikipedia.org/wiki/X-Ray\\_Imaging\\_and\\_Spectroscopy\\_Mission](https://en.wikipedia.org/wiki/X-Ray_Imaging_and_Spectroscopy_Mission).

Sometime in 2023: launch of *#dearMoon*, which will carry Japanese billionaire, Yusaku Maezawa, two crew members, and eight artists on a lunar free-return mission. For more information, visit [https://en.wikipedia.org/wiki/DearMoon\\_project](https://en.wikipedia.org/wiki/DearMoon_project)

Sometime in 2023: 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>. This is one of the missions that had to find a new ride after the Russian invasion of Ukraine.

Sometime in 2023: First flight of Blue Origin's *New Glenn* orbital rocket. For more information, see [https://en.wikipedia.org/wiki/New\\_Glenn](https://en.wikipedia.org/wiki/New_Glenn).

First Quarter in 2023: 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>.

First quarter of 2023: UK Pathfinder Launch, from SaxaVord Spaceport on Unst in the Shetland Islands to low Earth orbit. This, amazingly, will be the first orbital launch from the ground in the history of the United Kingdom. [I.e., not counting air launching of LauncherOne.]

January 2023 [moved from September 2022]: 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>. "Aditya" is Sanskrit for the Sun, aka Surya.

February 2023: First ISS Cargo Resupply mission for Dream Chaser.

February 2023: First crewed Starliner Mission to ISS, launched by Boeing.

March 2023: SpaceX's Sixth Crew Dragon mission to ISS

Second quarter of 2023: Launch of *Axiom-2* mission to the ISS, via Falcon 9. This carries one professional astronaut and three private astronauts. [Axiom 3 and 4 should also launch this year.]

April 2023: Maiden flight of Ariane 6.

April 5, 2023: Launch of *JUICE*, the Jupiter Icy Moons Explorer, by the European Space Agency. The JUICE web site is <https://sci.esa.int/web/juice>. This will also mark the final launch of *Ariane 5*.

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

June 4, 2023: Venus is at greatest elongation, 45.4 degrees east of the Sun (so can be seen after sunset).

July 2023: 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 13, 2023: Venus is in inferior conjunction with the Sun.

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

Fourth quarter of 2003: Second (uncrewed) *Gaganyaan* flight test.

Fourth quarter of 2003: China launches its *Xuntian* space telescope, which will orbit close to orbit close to *Tiangong* for easy servicing.

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.

October 23, 2023: Venus is at greatest western elongation, 46.4 degrees from the Sun (so can be seen before sunrise).

November 2023: Launch of Masten Mission One lander and Moon Ranger rover on the Moon via Falcon 9. They will land at Haworth Crater near the South Pole of the Moon. For more information, see [https://en.wikipedia.org/wiki/Masten\\_Space\\_Systems#Masten\\_Mission\\_One](https://en.wikipedia.org/wiki/Masten_Space_Systems#Masten_Mission_One).

Sometime in 2024: Launch of *Hakuto-R* mission 2, Japan's lunar lander and rover. For more information, see <https://en.wikipedia.org/wiki/Hakuto>. Sometime in 2024: First launch of Firefly's *Blue Ghost* lunar lander. For more information, see [https://en.wikipedia.org/wiki/Firefly\\_Aerospace#Blue\\_Ghost\\_lunar\\_lander](https://en.wikipedia.org/wiki/Firefly_Aerospace#Blue_Ghost_lunar_lander).

Sometime in 2024: Launch of the Hakuto-R Lunar Lander and Rover by SpaceX for ispace (Japanese company).

Sometime in 2024: JAXA launches *DESTINY+*, an asteroid flyby mission to Phaethon, the parent of the Geminid meteor shower. It will arrive there in 2028. For more information, see [en.wikipedia.org/wiki/DESTINY%2B](https://en.wikipedia.org/wiki/DESTINY%2B).

Sometime in 2024: India launches its first crewed orbital flight *Gaganyaan-3*

Sometime in 2024: India launches Mars Orbiter Mission 2.

Sometime in 2024: China has two lunar lander missions this year, the *Chang'e 6* sample return mission, and *Chang'e 7*, which include an orbiter, a rover and a hopping probe.

First half of 2024: Israel launches its *Beresheet 2* lander and orbiter on the Moon. For more information, see [en.wikipedia.org/wiki/Beresheet\\_2](https://en.wikipedia.org/wiki/Beresheet_2)

First quarter of 2024: A SpaceX Nova-C mission to the moon takes Intuitive Machines' IM-3 lander, NASA's Lunar Vertex rover, Lunar Outpost's M2 MAPP rover, and several NASA Cadre rovers.

Second quarter of 2024: Launch of the Mission Robotic Vehicle (MRV) which carries the RSGS (Robotic Servicing of Geosynchronous Satellites) to attach jet packs to remove dying satellites from orbit.

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: *Artemis 2*, the 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.

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\\_\(MMX\)](https://en.wikipedia.org/wiki/Martian_Moons_eXploration_(MMX)).

September 2024: Launch of the first Axiom Hub Module, probably on a New Glenn rocket.

September 2024: uncrewed test launch of *Orel*, Russia's new crewed spacecraft. For information, [https://en.wikipedia.org/wiki/Orel\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Orel_(spacecraft)). This is the first flight for Russia's Angara A5P spacecraft.

Fourth quarter of 2024: Impulse Space sends the Terran R lander to Mars. For more information, see [https://en.wikipedia.org/wiki/Terran\\_R](https://en.wikipedia.org/wiki/Terran_R).

October 2024: Launch of the *Hera* asteroid orbiter by the ESA, which contains the *Juventas* and *Milani* asteroid probes. Destination is the binary asteroid Didymos to evaluate the results of the DART asteroid impact mission.

October 2024: Launch of *Europa Clipper* orbiter. For more information, [https://en.wikipedia.org/wiki/Europa\\_Clipper](https://en.wikipedia.org/wiki/Europa_Clipper),

October 2024: *ESCAPADE Blue* and *Gold Mars Orbiters* launched.

November 2024: 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.

November 2024: 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.

December 2024: Launch of India's *Shukrayaan-1* Venus orbiter. For more information, see <https://en.wikipedia.org/wiki/Shukrayaan-1>.

December 2024: Launch of the Space Entertainment Enterprise's SEE-1 inflatable space habitat docked to the Axiom segment of the ISS.

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: Launch of *Artemis 3*, which will be the first crewed lunar landing since 1972.

Sometime in 2025: 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](https://en.wikipedia.org/wiki/Russian_Orbital_Service_Station).

September 2025: First crewed flight of Russia's *Orel* (formerly called *Federatsiya*), destined for the ISS.

December 2025: *BepiColombo* arrives at Mercury orbit.

Sometime in 2026: Launch test of China's Long March 5DY, which will eventually carry Chinese astronauts to the Moon.

First half of 2026: Launch of the *NEO Surveyor* which will be able to detect more than 90% of near-earth objects greater than 460 feet in diameter. For more information, see [https://en.wikipedia.org/wiki/NEO\\_Surveyor](https://en.wikipedia.org/wiki/NEO_Surveyor).

March 2026: Launch of *Artemis 4*, a Lunar Gateway expedition.

July 2026: *Hayabusa 2* flies by asteroid 2001 CC<sub>21</sub>.

October 2026 [Maybe]: 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](https://en.wikipedia.org/wiki/Nancy_Grace_Roman_Space_Telescope).

Sometime in 2027: Launch of the ESA's *Earth Return Orbiter* to Mars. This is the vehicle that will bring the *Perseverance* Mars samples to Earth.

Sometime in 2027: First flight of the ESA's HERACLES lunar Transport System. This is uncrewed and will carry cargo both to and from the Moon (including sample returns and lunar landers). For more information, see [https://en.wikipedia.org/wiki/HERACLES\\_\(spacecraft\)](https://en.wikipedia.org/wiki/HERACLES_(spacecraft)).

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: [tentative, postponed from 2022]: ESA launches the *ExoMars Mars Rover*, which has been christened *Rosalind Franklin*. For more information, visit <https://en.wikipedia.org/wiki/ExoMars>. Note: this is the mission most affected by Russia's invasion of Ukraine, since they were supposed to supply the landing platform.

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

Sometime in 2028: First flight of the Long March 9 super-heavy launch vehicle. This looks like it will be able to carry 53,000 kg to the Moon and 44,000 kg to Mars and will probably carry Chinese astronauts to the Moon.

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

November 2028: Launch of China's *Tianwen-2* Mars sample return mission.

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

Sometime in 2029: The *Psyche* asteroid probe arrives at the asteroid 16 Psyche. [This is assuming a 2023 launch.] For more information, visit [https://en.wikipedia.org/wiki/Psyche\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Psyche_(spacecraft)).

Sometime in 2029 [tentative]: Launch of the *Yenisei* lunar flyby mission. This will be the first Russian manned mission to the Moon (though it's not a landing).

June 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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E-mail for OSA should be sent to sydh at ou.edu. Members who wish their e-mail addresses printed in Outreach, and people wishing space-related materials e-mailed to them should contact Syd. Oklahoma Space Alliance website is <http://osa.nss.org> . Webmaster is Syd Henderson.

**Other Information**

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

Science Museum Oklahoma (former Omniplex) website is [www.sciencemuseumok.org](http://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](http://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](http://www.marsociety.org).

The National Space Society's Headquarters Executive Director e-mail [nsshq@nss.org](mailto:nsshq@nss.org). The Chapters Coordinator is Bennett Rutledge 720-641-7987, [rutledges@chapters.nss.org](mailto:rutledges@chapters.nss.org). The address is: National Space Society, PO Box 98106, Washington DC 20090-1600 Web page is [space.nss.org](http://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](http://www.planetary.org). E-mail is [tps@planetary.org](mailto:tps@planetary.org).

NASA Spacelink BBS 205-895-0028. Or try [www.nasa.gov](http://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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A Chapter of the National Space Society  
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To join the Mars Society, visit [www.marssociety.org](http://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. 8<sup>th</sup> Ave, Unit A, Lakewood, CO 80215.

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