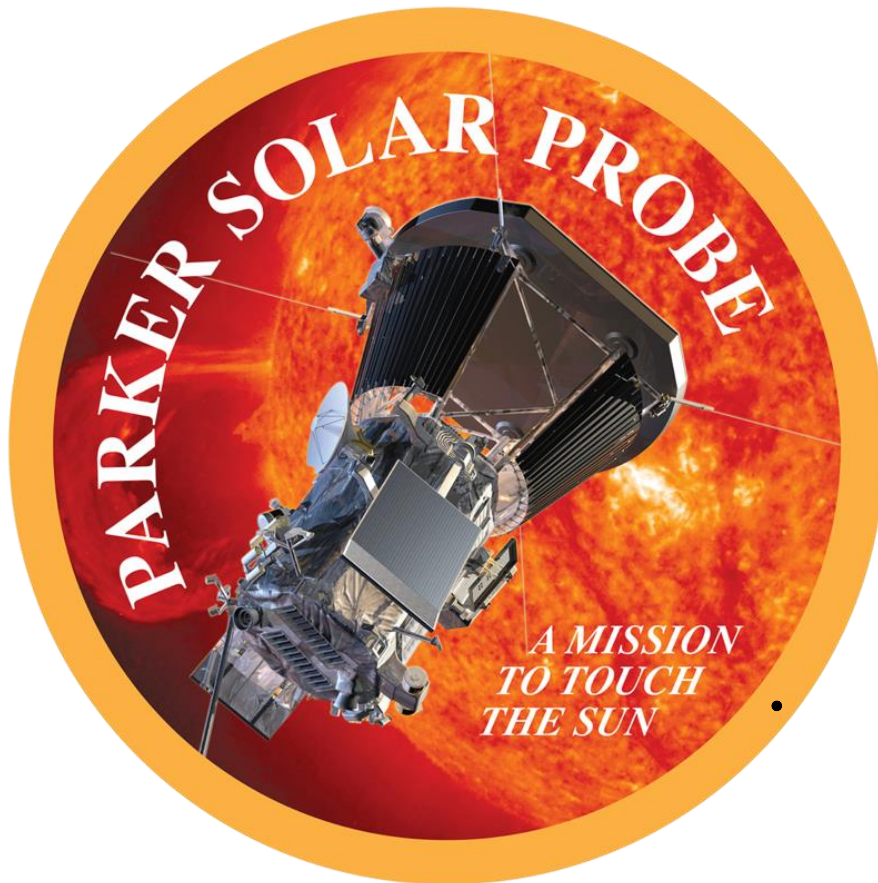


OKLAHOMA SPACE ALLIANCE

OUTREACH – January 2025

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet at the
at Cyber Hall and Gaming Lounge next to Norman Computer
at 2:00 p.m. on January 11, details inside



OKLAHOMA SPACE ALLIANCE OUTREACH January 2025

January Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, January 11, at the location next to Norman Computers on West Main in Norman. Prospective members are welcome.

The meeting room is in the Cyber Hall and Gaming Lounge next to Norman Computers. Please enter through the Cyber Hall door. The Cyber Hall is at 914 W Main St, opposite Norman High School. The phone number is (405) 292-9501. To get to the meeting space from points north, take the Highway 77 exit off I-35, and continue south until you reach Main Street. Norman Computers is about a block and a half west of this on the south (left) side of a small mall.

Saturday, January 11, 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 November meeting and December Party
 - c. Posters
 - d. Membership Business
5. Video (to be announced)
6. Chat

Minutes of December 14 Oklahoma Space Alliance Christmas Party

Oklahoma Space Alliance had its annual Christmas party at the McMurray residence on December 14. In attendance were Clifford and Claire McMurray, Mark Deaver, Adam Hemphill, John Northcutt Dave Sheely, Tim Scott, Syd Henderson, and one visitor whose name I didn't catch.

We had one item of business, which was to elect officers. We confirmed the slate for this year, which was Clifford McMurray for President, Dave Sheely for Vice-President, Syd Henderson for Secretary, and Tim Scott for Treasurer,

We had a prediction question to check out next year: How many Starship launches will there be this year. I said nine, and consensus seemed to be between that and a dozen,

The Orion capsule costs twenty billion dollars, while SLS costs thirty-two billion dollars.

Syd is having difficulty getting the website to update. FileZilla is updating its cache but isn't sending the updates to the website.

--Minutes By OSA Secretary Syd Henderson

Minutes of November 9 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met November 9, 2024, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending in person were Adam Hemphill,, Clifford and Claire McMurray, Mark Deaver (briefly), Dave Sheely, and Syd Henderson. OSA President Adam Hemphill presided over the meeting He and Clifford did an *Update* discussing links to material covered in the

meeting and this is online at <https://osa.nss.org/Update2411.pdf> so I'll cover the details that aren't covered there.

The next Starship launch will be in the afternoon and land in the next morning in the Indian Ocean. SpaceX has two launch towers so they can catch both the first stage and the spacecraft itself.

The Chinese startup Cosmoleap is also going to use "chopsticks" to catch its lander. The fourteen million in funding is clearly preliminary cost.

We watched the fifth Starship launch and recovery, including the catch.

For the Chinese version of COTS, Haolong is a cargo shuttle that will launch horizontally. Qingzhou will be a capsule and probably launch vertically.

We looked at an article on Long March 10A, which will eventually take Chinese astronauts and rovers to the Moon.

Don't know why Intelsat 33e broke up. It's in a relatively high orbit so the pieces won't be coming down anytime soon.

AstroForge may be the first to return metals for space (such as platinum for profit?)/ Platinum is currently \$987/oz, which is still less than the price of gold.

Wood satellites would burn up completely on re-entry. Wood also doesn't block radio transmissions. China used white oak for heat shields on some early rockets.

Adam thinks ESA may get more competitive in space, possibly beating out India.

We looked at an article on Axion-Prada spacesuits. They are also testing electrostatic repulsion to get rid of moon dust.

Voyager 1 is now almost one light-day away from Earth.

Officer nominations for 2025: Clifford McMurray for President, David Sheely for Vice President, Syd Henderson for Secretary, and Tim Scott for Treasurer.

The Oklahoma Space Alliance Christmas Party and election will be at either the Koszorus or the McMurrays. [Tom Koszoru was injured so the McMurrays will host-Syd].

Space News

At this writing, we are awaiting the first launch of New Glenn, currently scheduled for January 8. This is the *National Security Space Launch* demonstration flight. New Glenn is the heavy launch vehicle for Blue Origin and is fittingly named for the first American human to orbit the Earth. (Similarly, their suborbital launcher is New Shepard.) New Glenn has been in the works for thirteen years, to the point where people were starting to doubt if it ever would. There have been a bunch of delays since 2020. Since Blue Origin has a lot to do with the future Lunar base, the success of New Glenn is important even with the existence of SpaceX. One of these delays was to make the upper stage reuseable and make it more competitive with Falcon 9 and Falcon 9 Heavy. However, as far as I know, only the first stage is reuseable.

New Glenn will eventually be used to launch crews into orbit, but I don't know when the first crewed flight is anticipated.

On December 24, the Parker Solar Probe approached within 3.8 million miles of the surface of the Sun, the closest it has come (and will come), only 13 percent of the distance of the perihelion of Mercury. On this flyby, it became the fastest probe ever with a velocity of 430,000 mph (or 6.5 times that of Earth around the Sun). It survived its encounter, radioing home on December 26. It will be transmitting its data when it is farther away from the Sun, probably by the end of January.

Although this was the closest approach Parker will make, it will also make flybys on March 22 and June 19 at around four million miles from the Sun. It will also make flybys on September 15 and December 12. I gather it reaches perihelion at intervals just shy of three months. I've no idea when the mission will end. Probably when it runs out of fuel and gets perturbed into a different orbit. The aphelion of its orbit is just beyond the orbit of Venus, and it will occasionally come close enough to her or Mercury to change its orbit. Or perhaps it will eventually encounter a coronal mass ejection (CME) and get fried.

By the way, escape velocity from the Solar System from Earth's orbit is about 95,000 mph, but Earth's orbital velocity of 67,000 mph gives a big boost. And that is why escaping the Solar System is so much easier than going to Mercury orbit, let alone achieving the Parker Solar Probe orbit.

Speaking of which, we had several coronal mass ejections in the last year, most notably around May 11, 2024, which produced auroras visible through most of the United States, and there were some reports of auroras as far south as the Yucatan Peninsula and even Hawaii. In the Southern Hemisphere, auroras were visible in Namibia (so, presumably, South Africa, the southern third of South America, New Zealand and parts of Australia. So, basically, everywhere south of the Tropic of Capricorn.) These were the most severe solar events since 1989, but, unlike in 1921 and 1989, we didn't have severe blackouts. The 1921 event produced the southernmost auroras borealis ever recorded, although you have to think the Carrington Event of 1859 must have produced auroras even closer to the equator, and, sure enough, they reached Colombia. Possibly from the south as well as the north?

Anyway, the reason I brought this up is that the solar maximum for this solar cycle was last year and this year, so we might get even more CMEs this year, and more spectacular auroras. We seem to be doing a lot better at surviving them, but one study suggests that we may get a Carrington type event every century, and that would be a disaster if we were caught unprepared. However, it looks to me like the 1921 event is more likely the century event and Carrington was more like once a millennium. And indeed, there was an event in 774 AD that appears to have been considerably more powerful than the Carrington Event, judging from the amount of Carbon-14 created.

One of my sources for the above is the February issue of *Astronomy*, which listed the top ten space stories of 2024. #3 is "Sun's Wrath Thrills Solar Storm chasers." The other stories: (1) Discoveries and answers from the James Webb Space Telescope. (2) Back to the Moon (that will be one of the top five in each of the next few years). (4) "Starliner Test Flight Strands Astronauts. (5) "Eclipse Ecstasy". (6) "Sgr A* May Have a Jet." Sgr A* is the mega-black-hole at the center of the Milky Way. (7) "Meteorites Create the Moon's Atmosphere". (8) NASA rethinks how its going to retrieve the Mars samples *Perseverance* has been gathering. (9) "Gaia Discovers an Ancient, Heavy Black Hole," in this case a dormant black hole having a mass 33 times that of the Sun. This is the largest stellar mass black hole ever detected in the Milky Way. (10) Exoplanet atmospheres being explored in more detail.

Sky Viewing

Now that the Quadrantids have passed, there are no more meteor showers until April. Comet ATLAS is also up in the morning, but it is even lower in the sky than Mercury.

In the early of February 6. The Moon will occult the Pleiades, starting a little after one a.m. This is by no means a rare event; indeed, it happens once a month until July 2029, but it's not always visible from North America and half the occultations will occur during daytime. Which individual stars get occulted varies, but the Moon can cover them all.

Mercury has been having a decent morning apparition, rising about 6:45 a.m. local time, or about 45 minutes before sunrise. By January 16, it will be magnitude -0.5 but also be a bit more into twilight. Soon after that it will be lost in twilight as it approaches superior conjunction with the Sun on February 9. It will reappear in the west around the end of February, shining at a rather impressive magnitude -1.3. If you have a clear horizon (who does?) it should be easily visible in late twilight.

Venus is nearing peak magnificence as it is high in the sky after sunset. Outside of the Moon, it is, at magnitude -4.5, the brightest object in the night sky (and should not be mistaken for a drone – shudder). On January 9, Venus reached greatest eastern elongation and set four hours after the Sun. Venus actually gets brightest when it shows a fat crescent, and that will be in late January and early February, when it is magnitude -4.7.

Mars is at opposition with respect to the Sun on the night of January 15 – 16, and, although this isn't a good opposition, it still is pretty bright at magnitude -1.4. This is about as bright as Sirius, but at a

good opposition, Mars can be as bright as Jupiter. On January 13, Mars will be occulted by the Moon as seen from all the contiguous United States. I'd start looking around 7:30 p.m. Mars fades quickly after opposition but will still be in negative magnitudes during February and will be visible all night.

On December 7, **Jupiter** was at opposition with respect to the Sun, which means it is still visible for most of the night and is at its brightest at magnitude -2.7. It will be nestled between the horns of Taurus the Bull for the rest of the year. It and Aldebaran make a nice pairing. Jupiter will remain in Taurus through the end of May, gradually moving between the horns as it approaches Gemini, but staying about as bright.

Saturn is now four months past opposition and down to magnitude 1.0. It is also about a fist-width above Venus and closing in, with a conjunction on January 18, but three degrees apart, which is six times the width of the Full Moon. By the end of January, it will be setting about 8:00 p.m., and by mid-February it will be lost in twilight. Conjunction is March 11.

Saturn's rings are now almost on edge, and will actually be on edge on March 23, discreetly hidden in twilight. For some reason, the rings are at their narrowest this November, which doesn't seem right to me. So, it will be a bad year to look at Saturn's rings but a great one to look at its moons. After that, the rings will gradually become more visible until 2032, at which time we will also have best visibility of Saturn's south pole. (At 26.5 degrees, Saturn has about the same axial tilt as Earth and Mars.)

Uranus is near the border of Taurus and Aries on the western side of Taurus. At magnitude 5.7, it is theoretically visible to the naked eye under totally dark skies, but you'll need binoculars at least to identify it. Its blue tinge helps. Uranus actually moved into Taurus for a while last fall, but retrograde motion took it back to Aries. Around March 1, it moves into Taurus, where it will remain until 2032. It's south and a little west of the Pleiades. To search for Uranus, try <https://lovethenightsky.com/see-uranus-through-a-telescope>

Neptune, at magnitude 7.9, definitely requires a strong pair of binoculars or a telescope. It's a difficult object to search for, but <https://lovethenightsky.com/see-neptune-through-a-telescope/> should be a help. Like Uranus it has a definite blue tinge that will help distinguish it from background stars. Neptune has the advantage that if you find it at all, it will be in about the same place for the next year or two.

Viewing Opportunities for Satellites (January 10 – February 12, 2025)

You can get sighting information at www.heavens-above.com, which gives you a constellation map showing the trajectory of the satellite. 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. 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 is more likely. *Tiangong* is the Chinese Space Station. It currently gets up to magnitude -2.2 after the addition of the Wentian module last July and will do so several times below.

The "mag." beside the date indicates the brightest magnitude the satellite gets during the pass. All the ISS passes get between -2.9 and -3.9, 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 next launch to the ISS is a Progress module on February 28, so that won't affect these times. The next launch to *Tiangong* is in April. There will be no launches to Hubble in the foreseeable future. Also note that the ISS (and presumably *Tiangong*) sometimes have to alter orbits to avoid space debris. Hubble is high enough that this is less of a concern.

The information below is from Heavens Above.

Tiangong 1/10 mag. -2.2		
Time	Position	Elevation
6:42 p.m.	294°	10°
6:45:26	208	86
6:47:20	117	22
Vanishes into Earth's shadow		

Tiangong 1/12 mag. -1.1		
Time	Position	Elevation
6:18 p.m.	284°	10°
6:21	210	45
6:24	136	10

ISS 1/13 mag. -3.5		
Time	Position	Elevation
6:41 p.m.	236°	10°*
6:44:37	314	65
6:46:41	38	21
Vanishes into Earth's shadow		
*Passes just north of Venus		

HST 1/21 mag. 2.1		
Time	Position	Elevation
6:53 p.m.	239°	10°
6:56:53	177	29
6:59:20	125	16
Vanishes into Earth's Shadow		

HST 1/22 mag. 2.1		
Time	Position	Elevation
6:30 p.m.	240°	10°
6:33	178	30
6:36	116	10

Tiangong 1/25 mag. -2		
Time	Position	Elevation
6:39 a.m.	239°	10°
6:42	154	75
6:45	68	10

Tiangong 1/27 mag. -2.2		
Time	Position	Elevation
Appears from Earth's shadow		
6:14:40 a.m.	275°	44°
6:15:28	338	65
6:19	61	10

ISS 1/30 mag. -3.9		
Time	Position	Elevation
7:04 p.m.	366°	10°
7:07:40	41	71
7:09:23	121	25*
Vanishes into Earth's shadow		
*Passes between Jupiter and Mars		

ISS 2/1 mag. -2.1		
Time	Position	Elevation
7:00 p.m.	295°	10°
7:03	228	35
7:06	160	10
Passes just above Venus.		

Tiangong 2/5 mag. -2.2		
Time	Position	Elevation
Appears from Earth's shadow.		
6:41:37 a.m.	293°	14°
6:44:17	206	83
6:47	118	10

ISS 2/12 mag. -2.7		
Time	Position	Elevation
6:23 a.m.	275°	10°
6:26	134	41
6:29	60	10

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 spans about ten degrees. "Elevation" is elevation above the horizon in degrees. So, to view the ISS at 7:07:40 p.m. on January, measure four fist-widths east of due north, then seven fist-widths above the horizon.

Programming Notice: NASA+ on the Web

NASA-TV has become NASA+ <https://plus.nasa.gov/>
 NASA+ live event schedules are available at <https://www.nasa.gov/live/> or
<https://plus.nasa.gov/scheduled-events/>.

Calendar of Events

Sometime in 2025 (most likely September): End of *JUNO* mission to Jupiter.0

Sometime in 2025: Israel launches its *Beresheet 2* landers (two of them) and orbiter to the Moon.

For more information, see en.wikipedia.org/wiki/Beresheet_2.

Sometime in 2025: Launch of the *LSAS lunar lander*, a joint project of the European Union and Israel.

Sometime in 2025: Launch of *Skynet 6A* by Airbus and the UK Ministry of Defense, which will catapult us into the Terminator universe.

Sometime in 2025: Uncrewed Starship lunar landing demonstration.

First half of 2025: In flight fuel transfer from Starship to a target.

First half of 2025: Commercial Lunar Payload Services (CLPS) delivers lunar lander to the Gruithuisen Domes and the western edge of Mare Imbrium.

First quarter of 2025: First flight test of ESA's uncrewed Space Plane *Vega-C*. For more information, see https://en.wikipedia.org/wiki/Vega_C.

First Quarter of 2025 [Moved from 2024]: Maiden flight of *Pallas-1* launch vehicle by Galactic Energy in China. For information, see en.wikipedia.org/wiki/Pallas-1.

January [Moved from 2024]: First flight of *Eris*, from Bowen Spaceport at Abbot Point in Queensland, Australia. If successful, this will give Australia the ability to launch its own satellites.

January [Moved from November 2024]: Launch by Falcon 9 of Firefly's *Blue Ghost* lunar lander to Mare Crisium, including *Hakuto R Mission 2*'s iSpace's Resilience lunar lander and a Luxembourg (!) iSpace Europe lunar mini-rover to Mare Crisium For more information, see https://en.wikipedia.org/wiki/Firefly_Aerospace_Blue_Ghost.

January [Moved from December 2024]: Launch of the *Venus Life Finder Probe and Photon* relay satellite to Venus by RocketLab's Electron Booster. For more information, visit https://en.wikipedia.org/wiki/Venus_Life_Finder. [Note: this not mentioned on Wikipedia's launch page so I'm not certain if it's still on.]

January 9: Venus is at its greatest eastern elongation, 47.2 degrees east of the Sun (so can be seen after sunset).

January 10: Seventh *Starship* orbital test flight. This one carries a bunch of Starlink simulators and is the first flight of a Starship Block 2.

January 15: Mars is at opposition, 60 million miles from Earth. In other words, this is a poor opposition.

February: First (uncrewed) *Gaganyaan* flight test. For more information, see https://en.wikipedia.org/wiki/Gaganyaan_1.

February 9: Mercury is at superior conjunction with the Sun.

February 27 [Moved from January]: Launch of the *IM-2 South Pole Mission*, including the Polar Resources Ice Mining Experiment 1 (PRIME-1), the IM-2 Lunar Lander, the Lunar Trailblazer orbiter, the Micronova Lunar Hopper, and the M1-MAPP demo lunar rover. The last is a joint US/Finnish mission. Also on this flight is Tanker-002, an in-space refueling satellite from Orbit Fab. This is the second NOVA-C mission.

March: *Fram2*, a four-passenger civilian flight by Crew Dragon. This will be the first crewed flight ever launched into polar orbit. For more information, visit <https://en.wikipedia.org/wiki/Fram2>.

March: Launch of Russia's *Bion -M No. 2*, to observe the effects of the Van Allen radiation belts on mice over a period of 30 days.

March: *New Glenn* will carry a prototype Blue Moon lunar lander to the Moon. This is known as *Pathfinder Mission 1*.

March 7: Mercury is at its greatest eastern elongation, 18.2 degrees east of the Sun (so can be seen after sunset).

March 11: Saturn is in conjunction with the Sun.

March 14: Total eclipse of the Moon, visible throughout the Americas.

March 19: Neptune is in conjunction with the Sun.

March 22: Venus is in inferior conjunction with the Sun.

March 24: Mercury is in inferior conjunction with the Sun.

March 25 [Moved from February]: SpaceX launches SpaceX *Crew-10* to the ISS. This is the mission that will allow the *Boeing Crew Flight Test* crew to finally come home (aboard *Crew-9*, which has been serving as a lifeboat).

Second quarter of 2025 [moved from September 2024]: *ESCAPADE Blue* and *Gold* Mars Orbiters launch by New Glenn. For more information, see en.wikipedia.org/wiki/EscaPADE.

Second quarter of 2025: Launch of *Axiom-4 (Ax-4)* mission to the ISS, via Falcon 9. This carries one professional astronaut and three private astronauts, including the winner of the *Space Hero* reality show. For more information, see https://en.wikipedia.org/wiki/Axiom_Space.

April: Third and last Cygnus launch to the ISS.

April 8: Soyuz launch of Expedition 72/73 to the ISS from Baikonur Cosmodrome.

April 20: *Lucy* flies by asteroid 52246 Donaldjohanson.

April 22: Mercury is at its greatest western elongation, 27.4 degrees west of the Sun (so can be seen before sunrise).

April 21-22: Peak of Lyrid meteor shower.

May: First *Dream Chaser* cargo mission via Vulcan Centaur. This is the mission that was supposed to go up in July 2024.

May: Launch of *Tianwen-2* (formerly *Zheng He*), China's asteroid sample return mission and comet orbiter, which will visit Earth's co-orbital asteroid Kamo'oailewa and comet 311P/PANSTARRS,. For more information, see <https://en.wikipedia.org/wiki/Tianwen-2>.

May: Maiden flight of the *Tianlong 3* launch vehicle.

May 3-4: Peak of Eta Aquariid meteor shower. This is one of the two showers originating from Halley's Comet.

May 29: Mercury is in superior conjunction with the Sun.

May 31: Venus is at its greatest western elongation, 45.9 degrees west of the Sun (so can be seen before sunrise).

June: Maiden flight of LandSpace's *Zhuque-3* orbital launch vehicle.

June 24: Jupiter is in conjunction with the Sun.

Second half of 2025 (not in July!): first crewed mission to Vast's *Haven-1* space station. For more information, <https://en.wikipedia.org/wiki/Haven-1>.

Second half of 2025: First launch of Stoke Space's *Nova* Rocket.

Second half of 2025: Several launches of Orbex (Orbital Express Launch Ltd.)'s *Prime* rocket. This is a small launcher; what is notable is that this will launch from SaxaVord Spaceport in the Shetland Islands, making it possible the first orbital launcher from the UK, and by a private company at that.

July: *Mission Possible*, a demonstration flight of the Nyx reusable spacecraft by the Exploration Company a French-German enterprise.

July [Moved from March]: Launch of South Korea's *Hanbit-Nano* from Alcântara Space Center in Brazil. This is the first private launch from Alcântara.

July 3: Mercury is at its greatest eastern elongation, 25.9 degrees east of the Sun (so can be seen after sunset).

July 27: Peak of Southern Delta Aquariid meteor shower.

July 31: Mercury is in inferior conjunction with the Sun.

August: First operational crewed mission of *Starliner 1* to the ISS. This now seems doubtful, with SpaceX's Crew-11 taking this spot. For more information, visit https://en.wikipedia.org/wiki/Boeing_Starliner-1.

August: launch of Vast's *Haven-1* space station. For more information, <https://en.wikipedia.org/wiki/Haven-1>.

August 12 – 13: Peak of Perseid meteor shower.

August 19: Mercury is at its greatest western elongation, 18.6 degrees west of the Sun (hence can be seen before sunrise).

September [moved from April]: Launch of *IMAP* heliophysics probe L1 Lagrangian point (the one between us and the Sun). For more information, visit https://en.wikipedia.org/wiki/Interstellar_Map-ping_and_Acceleration_Probe and https://en.wikipedia.org/wiki/Space_Weather_Follow_On-Lagrange_1

September 7: Total lunar eclipse, visible throughout the Old World. The only part of the Americas that can see any of this is eastern Brazil.

September 13: Mercury is in superior conjunction with the Sun.

September 20: Saturn is at opposition.

September 23: Neptune is at opposition.

Fourth quarter of 2025: *Axiom-5*, a four-person fourteen-day mission to the ISS.

Fourth quarter of 2025: Launch of **CLPS** mission to the Lunar South Pole, including PROSPECT. CLPS=Commercial Lunar Payload Services.

October: A SpaceX *Nova-C* mission to the Moon takes Intuitive Machines' IM-3 lander, NASA's Lunar Vertex rover, and several NASA Cadre rovers.

October 8 – 9: Peak of Draconid meteor shower.

October 22 – 23: Peak of Orionid meteor shower. This is the other meteor shower originating from Halley's Comet.

October 29: Mercury is at its greatest eastern elongation, 23.9 degrees east of the Sun (so can be seen after sunset).

November [moved from September]: Astrobiotic's *Griffin Mission 1*, including lunar lander and CubeRover. They leave Earth on a Falcon Heavy. This was originally going to carry *VIPER*, which has been cancelled.

November 5: Peak of South Taurid meteor shower.

November 12: Peak of North Taurid meteor shower.

November 16 – 17: Peak of Leonid meteor shower.

November 20: Mercury is in inferior conjunction with the Sun.

November 21: Uranus is at opposition.

December 7: Mercury is at its greatest western elongation, 20.7 degrees west of the Sun (hence can be seen before sunrise).

December 13 – 14: Peak of Geminid meteor shower.

December 21 – 22: Peak of Ursid meteor shower,.

Sometime in 2026: Launch of ispace's *Mission 3*. First flight of ispace's APEX 1.0 lunar lander.

Sometime in 2026: Launch of Japan's *Martian Moons Exploration* (MMX) which includes a Phobos lander and sample return. For information, see [en.wikipedia.org/wiki/Martian_Moons_Exploration_\(MMX\)](https://en.wikipedia.org/wiki/Martian_Moons_Exploration_(MMX)).

Sometime in 2026 [Moved from 2025]: Second (uncrewed) *Gaganyaan* flight test. This one will carry the Vyommitra humanoid robot.

Sometime in 2026 [Moved from 2025]: Third (uncrewed) *Gaganyaan* flight test. This one will carry the Vyommitra humanoid robot. For more information on the Gaganyaan program, see <https://en.wikipedia.org/wiki/Gaganyaan>.

Sometime in 2026 [maybe]: India launches its first crewed orbital flight *Gaganyaan 4*. For more information on the Gaganyaan program, see <https://en.wikipedia.org/wiki/Gaganyaan>.

Sometime in 2026 [moved from 2024]: India launches *Mars Orbiter Mission 2* (MOM 2 or *Mangalyaan 2*). For information, see https://en.wikipedia.org/wiki/Mars_Orbiter_Mission_2.

Sometime in 2026: Maiden flight of *Terran R* mission to Mars from Impulse Space. For more information, en.wikipedia.org/wiki/Terran_R.

Sometime in 2026: Launch of MIT's *Venus Habitability Mission*.

Sometime in 2026: second *Blue Ghost* mission, carrying *Lunar Pathfinder* to the far side of the Moon. (Lunar Pathfinder is not to be confused with UK Pathfinder which failed launch in 2024, Intuitive Machines GEO Pathfinder, which is a variant of SHERPA, or Pathfinder Mission 1, which is part of the Blue Moon program.)

Sometime in 2026: *Gaganyaan-5*, India's second crewed spaceflight.

Sometime in 2026: *Gaganyaan-6*, India's first resupply mission to the ISS.

Sometime in 2026: Maiden flight of *Volans*, the first orbital launch vehicle developed in Singapore.

Sometime in 2026: Launch of *Canadensys* lunar rover, the first for Canada.

First quarter of 2026: Launch of *Daytona 1*, carrying the first pair of satellites for Tropical Weather Analytics' Hurricane Hunter Satellite Constellation. Daytona is a series of launchers for the Phantom Space Corporation, en.wikipedia.org/wiki/Phantom_Space_Corporation#Daytona

April 2026 [Moved from September 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. For more information, visit https://en.wikipedia.org/wiki/Artemis_2.

Mid-2026: *Starship* launch of the *Starship HLS* lunar lander and FLEX, Astrolab's demo lunar lander. *Starship HLS* is the craft SpaceX will use to transfer astronauts to the Moon.

May 2026: The *Psyche* probe flies by Mars.

Second half of 2026: *ClearSpace-1* will capture *PROBA-1* and deorbit it.

July 2026: *Hayabusa 2* flies by 98943 Torifune.

Fourth quarter of 2026: China launches the lunar mission *Chang'e 7*, which includes an orbiter, a lander and a hopping probe. For more information, see https://en.wikipedia.org/wiki/Chang%27e_7.

Fourth quarter of 2026: China launches its *Xuntian* space telescope, which will orbit close to orbit close to *Tiangong* for easy servicing. For more information, visit <https://en.wikipedia.org/wiki/Xuntian>

October 2026: Launch of the *Nancy Grace Roman Space Telescope* [formerly known as WFIRST] to the Earth-Sun L2 point. For more information, see https://en.wikipedia.org/wiki/Nancy_Grace_Roman_Space_Telescope.

November 2026 [postponed from December 2025 due to a thruster problem]: *BepiColombo* arrives at Mercury orbit.

December 28, 2026: *Hera* arrives at the binary asteroid Didymos (the one we hit with an impactor).

Sometime in 2027: Launch of the first two modules of the *Lunar Orbiter Platform Gateway* by SpaceX's Falcon Heavy. These were originally going to be launched on separate spacecraft but are now bunked together.

Sometime in 2027: First flight of *Long March 10*, which will be China's vehicle for crewed Moon missions.

Sometime in 2027: Launch of *NEM-1*, the core module of the *Russian Orbital Service Station*, or *ROSS*. For more information, see https://en.wikipedia.org/wiki/Russian_Orbital_Service_Station.

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

Sometime in 2027: Launch of *Luna 26*, the Luna-Resurs-Orbiter. This mission is in tandem with next year's Luna 27 lander. For more information, see https://en.wikipedia.org/wiki/Luna_26.

Sometime in 2027: USSF's *DRACO* demonstration of a nuclear thermal rocket in low-Earth orbit. For more information, see en.wikipedia.org/wiki/Demonstration_Rocket_for_Agile_Cislunar_Operations.

Sometime in 2027: Launch of the *Payload Power Thermal Module*, the first module of Axiom's space station. It will dock with ISS and await the arrival of *Hab-1*, which it will dock with as part of a free-flying space station.

Mid 2027 [Moved from September 2026]: Launch of *Artemis 3*, which will be the first crewed lunar landing since 1972. For information, see en.wikipedia.org/wiki/Artemis_3.

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.

September 2027 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.

September 15, 2027: *Lucy* flies by Trojan asteroid 15094 Polymele.

Sometime in 2028: JAXA launches *DESTINY+*, an asteroid flyby mission to Phaethon, the parent of the Geminid meteor shower. It will arrive there in 2029. For information, see en.wikipedia.org/wiki/DESTINY%2B.

Sometime in 2028: Launch and landing of Japan/India *LUPEX* (Lunar Polar Exploration) lander. India knows this as Chandrayaan-5. For more information, see https://en.wikipedia.org/wiki/Lunar_Polar_Exploration_Mission.

Sometime in 2028: Launch of *Luna 27*, the Luna-Resurs Lander which will land in the South Pole-Aitkin Basin on the far side of the Moon. This mission is in tandem with 2027's Luna 26 orbiter. For more information, see https://en.wikipedia.org/wiki/Luna_27#Science_payload.

Sometime in 2028: Launch of *Chang'e 8*, which will include a lander, rover and a 3D printing experiment using lunar resources. This will be the last Chang'e mission before China sends a human crew to the Moon.

Sometime in 2028: Launch of the *Sample Retrieval Lander* to Mars. This is part of a joint NASA/ESA mission and will include Ingenuity class helicopters. [There's a very good chance that this will be delayed for up to a decade.]

Sometime in 2028: first uncrewed test launch of *Orel*, Russia's new crewed spacecraft, with first crewed launch later in the year. For information, [https://en.wikipedia.org/wiki/Orel_\(spacecraft\)](https://en.wikipedia.org/wiki/Orel_(spacecraft)).

Sometime in 2028: Launch of the first module of India's *Bharatiya Antariksha* space station. For more information, see https://en.wikipedia.org/wiki/Bharatiya_Antariksha_Station.

First quarter of 2028: Launch of the *Emirates Asteroid Mission* to the asteroid belt, where it will make at least seven flybys of asteroids, the largest of which are Chimaera and Justitia. [See May 2035.]

March 29, 2028: Launch of India's *Shukrayaan-1* Venus orbiter. For more information, see <https://en.wikipedia.org/wiki/Shukrayaan-1>.

April 2028: Launch of ESA's *Ramses* spacecraft, which will fly by Apophis.

April 18, 2028: *Lucy* encounters asteroid 11351 Leucus.

July 2028: Launch of *Dragonfly*, the Titan helicopter mission. For information, see [en.wikipedia.org/wiki/Dragonfly_\(spacecraft\)](https://en.wikipedia.org/wiki/Dragonfly_(spacecraft)).

September 2028: Launch of *Artemis 4*, a Lunar Gateway expedition which will also land four astronauts on the Moon.

October 2028: ESA launches the *ExoMars Mars Rover*, which has been christened *Rosalind Franklin*. For more information, visit <https://en.wikipedia.org/wiki/ExoMars>.

November 11, 2028: *Lucy* flies by Trojan asteroid 21900 Orus.

Sometime in 2029: Launch of the *ARIEL Space Telescope* and the *ESA/JAXA Comet Interceptor* mission via Ariane 62 to the Sun-Earth L₂ point, where the Interceptor will wait for a long-period comet to come by.

April 21, 2029: *OSIRIS-APEX* rendezvous with the asteroid Apophis. Note: *OSIRIS-APEX* is the same spacecraft as *OSIRIS-REx*; it is renamed "Apophis Explorer" for this part of its mission.

August 2029: The *Psyche* asteroid probe arrives at asteroid 16 Psyche. For more information, visit [https://en.wikipedia.org/wiki/Psyche_\(spacecraft\)](https://en.wikipedia.org/wiki/Psyche_(spacecraft)).

September 2029: Launch of *Tianwen 4* which will carry a Jupiter orbiter and a mission to Uranus. The Uranus spacecraft will eventually leave the solar system, something that only the US has achieved.

Sometime in 2030: *DESTINY+* flies by asteroid 3200 Phaethon, the parent body of the Geminid meteor shower.

Sometime in 2030: Russia launches *Boomerang*, aka *Fobos-Grunt 2*, which will return samples from Mars's moon Phobos. (*Fobos-Grunt 1*) failed in low-Earth orbit in 2011.)

Sometime in 2030 [Moved from November 2028]: Launch of China's *Tianwen-3* Mars sample return mission.

Sometime in 2030: China will land a crewed mission on the Moon.

Sometime in 2030: Launch of the ESA's *NEOMIR* (Near-Earth Object Mission in the Infrared).

Sometime in 2030: Launch of Russia's *Luna 28* sample return mission.

Sometime in 2030: Maiden flight of *Siraya*, Taiwan's first orbital launch vehicle.

Sometime in 2030: Launch of *UVEX*, NASA's Ultraviolet Explorer wide-field ultraviolet telescope.

March 2030 {moved from September 2029}: Launch of *Artemis 5* to the Moon. This mission carries the ESPRIT Refueling Module to the Lunar Gateway, and a crew and the crewed Lunar Terrain Rover.

April 2030: *Europa Clipper* arrives at Jupiter.

Sometime in 2031: Russia launches the *VENERA-D* Venus orbiter and lander. For more information, visit <https://en.wikipedia.org/wiki/Venera-D>.

Sometime in 2031: Launch of the first of ESA's Argonaut lunar landers.

March 2031 [Moved from September 2030]: Launch of *Artemis 6* to the Moon.

Spring 2031: *Europa Clipper*'s first flyby of Europa.

June 2031 [Moved from 2029]: Launch of *VERITAS* orbiter and Venus Atmosphere Sample Return Mission to Venus. For more information, see [https://en.wikipedia.org/wiki/VERITAS_\(spacecraft\)](https://en.wikipedia.org/wiki/VERITAS_(spacecraft)).

July 2031: *Hayabusa 2* arrives at asteroid 1998 KY26.

July 2031: *JUICE* flies by Ganymede then is inserted into Jupiter orbit.

December 2031: Launch of ESA's *EnVision* Venus orbiter.

Sometime in 2032: Launch of the *Yenisei* lunar flyby mission. This will be the first Russian manned mission to the Moon (though it's not a landing).

Sometime in 2032: Launch of first South Korean lunar lander.

March 2032 [Moved from September 2031]: Launch of *Artemis 7* to the Moon. This will include the crewed Lunar Cruiser rover built in Japan.

Sometime in 2033: Launch of *Artemis 8* to the Moon, which includes the first component of the Artemis Base Camp.

Sometime in 2033: 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.

March 2, 2033: *Lucy* flies by the double Trojan asteroid 617 Patroclus-Menotius. I believe these are the largest asteroids it will encounter.

December 2034: *Juice* achieves Ganymede orbit.

Sometime in 2035: Launch of *LISA* gravitational wave observatory.

May 2035: The *Emirates Asteroid Mission* touches down on Justitia.

Sometime in 2036: *Dragonfly* arrives at Titan.

August 12, 2045: The next total solar eclipse is 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, 2025

Clifford McMurray, President and *Update* Editor

405-329-4326 (H) 405-863-6173 (C)

Dave Sheely, Vice-President, 405-821-9077 (C)

Syd Henderson, Secretary & *Outreach* Editor,

405-321-4027 (H) 405-365-8983 (C)

Tim Scott, Treasurer, 405-740-7549 (H)

OSA E-mail Addresses and Web Site:

ahemphil at gmail.com (Adam Hemphill)
 cliffmcmurray at hotmail.com (Claire & Clifford McMurray)
 sheely at sbcglobal.net or david.sheely.1 at us.af.mil (David Sheely)
 sydh at ou.edu (Syd Henderson)
 sswift42 at aol.com (Steve Swift)
 ctscott at mac.com (Tim Scott)
 t_koszoru01 at cox.net (Heidi and Tom Koszoru)
 john.d.northcutt1 at tds.net (John Northcutt)
 lensman13 at aol.com (Steve Galpin)

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://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 The Mars Society, 11111 West 8th Avenue, Unit A, Lakewood, CO 80215. Phone: (303) 980-0890 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, 1300 I Street NW, Suite 400E, Washington, DC 20005. Phone (321)452-2448. Web page is space.nss.org.

The Planetary Society phone 626-793-5100. The address is 60 South Los Robles Avenue, Pasadena, California, 91101, 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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