

OKLAHOMA SPACE ALLIANCE

OUTREACH – July 2026

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 July 11, details inside

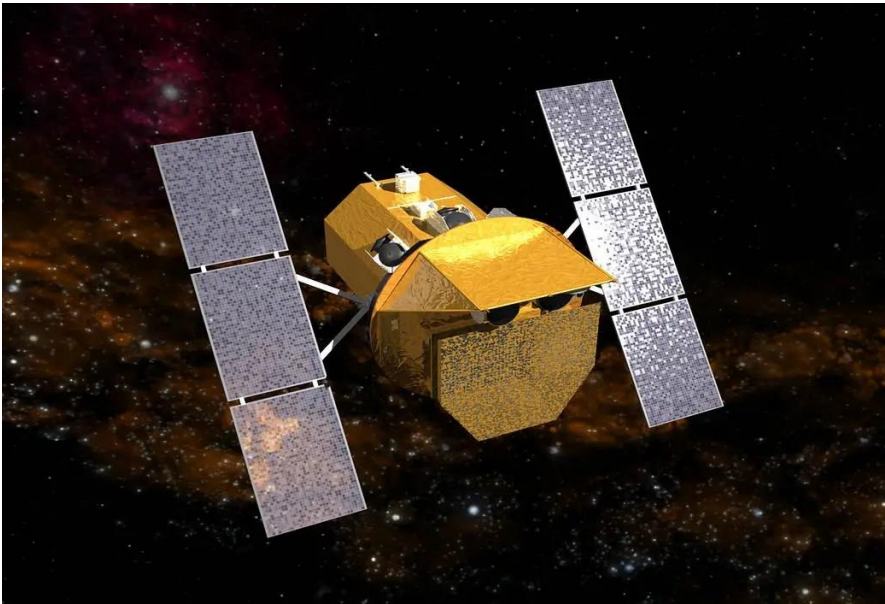


Figure 1 Beil Gehreis Swift Observatory awaiting boost (See page 7) NASA image

OKLAHOMA SPACE ALLIANCE OUTREACH

July 2026

July Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, July 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 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, July 11, 2:00 p.m.

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 May and June Meeting
 - c. Plans for 2026
 - d. ISDC 2026
5. Video (to be announced)
6. Chat

Minutes of June 13 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met June 13, 2026, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending were Adam Hemphill, Mark Deaver, Clifford McMurray, Tim Scott, Dave Sheely and Syd Henderson. Instead of our usual presentation of space news, Adam did a presentation on the viability of Data Centers in space. This meant there was no June *Update*.

Adam's major presentation was Scott Manley's YouTube presentation

<https://www.youtube.com/watch?v=FIQYU3m1e80&t=27s> (also available at https://www.reddit.com/r/SpaceXLounge/comments/1rxec49/is_it_really_impossible_to_cool_a_datacenter_in/)

The problem is that cooling involves heat transfer, which can be done by conduction, convection and radiation. Conduction and convection do not work in a vacuum, so to cool the data center (which produces large amounts of heat) you need radiators of some type to have the surface area to radiate heat from the data center. You do have to pump heat from the data center to the radiators, which you can do if the radiators are cooler than the data center. But loss of heat by radiation is much more efficient at high temperatures¹, while data centers will not work at high temperatures.

Thus, you need a large surface area for the radiators, but you also have to be careful not to expose too much of their surface area to the sun. You will have to put them edge-on to the Sun while the solar panels are face on to the Sun, supplying the energy to run the data center. Of course, that energy is what is converted to the heat you're trying to get rid of.

In addition, the spacecraft will be getting thermal radiation from the Earth, both through reflection from the Earth's surface (during the day) and the Earth's own thermal radiation. For a spacecraft directly between the Earth and the Sun, this can amount to a third of the radiation from the Sun.

Manley does the rough calculations for a satellite that uses 20 kW of powers and it's tricky but probably doable, but Musk is talking about 100 kW servers and that's trickier, because we are talking about drastically increasing the size of

¹ By the Stefan-Boltzmann Law, which says that thermal radiation increases as the fourth power of temperature in degrees Kelvin. This, incidentally, is also how you can work out the size of a star from its temperature and luminosity.

the solar panels, hence also of the radiator panels. He calculates you will have to move 70 liters of water to the radiator panels per minute to remove 100 kW of heat, which means you are using extra energy to pump the coolant. Water is not the ideal coolant for this because it expands when it cools. (The ISS uses ammonia, which has its own problems, while the Russians use glycol).

We also watched a video with Elon Musk on this and also his proposed giant Tesla facility.

Kip went to the ISDC and did some reports, including on the UCF (University of Central Florida) Space Ideation Challenge. For more information, see <https://business.ucf.edu/space-ideation-challenge/>.

Minutes by OSA Secretary Syd Henderson

Minutes of May 9 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met May 9, 2026, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending were Clifford McMurray, Adam Hemphill, Mark Deaver (briefly), John Northcutt, Tim Scott, Dave Sheely and Syd Henderson, with Robin Scott joining us by phone. 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 <https://osa.nss.org/Update2605.pdf> so I'll cover the details that aren't covered there.

Bluebird 7 has a 2400 square meter antenna.

The goal for New Glenn is 25 flights for each first stage.

Reports are that Iran not only has access to Chinese satellites in the US-Iran war, but also Russian satellites.

If both SpaceX and Blue Origins are ready, we'll have SpaceX, New Glenn and SLS ready for launch in a short period of time. If they go for one launch every ten months, they can't do two launches to the Moon in 2028 unless the first launch is before April. [Two launches seem even more unlikely due to the New Glenn launchpad explosion, though it's possible Blue Moon may be able to fly on a different rocket.—SFH]

Blue Origin anticipates twelve launches in 2026 and 50 by third quarter of 2028 and 100 by the end of 2029. [Obviously this is delayed because they need to repair the launch pad.]

In addition to corrosion issues on Gateway modules, there are corrosion issues on Axiom 1 and modules for the ISS. Issue reports apparently were withheld, Corrosion issues will be fixed by the end of the third quarter of this year.

SpaceX IPO is scheduled for Elon Musk's birthday on June 28.

Firefly is also working on launching from Wallops Flight Facility (on the Delmarva Peninsula). So far they have launched from Vandenberg, and they want to launch from Sweden in 2028. [In which direction?—SFH]

Kip: In all fairness, The FAA's launch fee could help deal with the increase of launches.

The fee starts at 25 cents per pound and goes up by ten cents per pound per year until it finally peaks at \$1.50 in 2033, with a cap of \$30,000 per launch or reentry. [I don't know if this means some launches may have to pay \$60,000 but I suspect so.]

The Oklahoma Air and Space Port has been renamed Infinity One Oklahoma Spaceport. From the report on Channel 5 news in OKC. The renaming is promoted by the contract with Dawn Aerospace. The renovation of Burns Flat spaceport will cost \$30 million. They say Dawn's spaceplane has launched sixty times so far.

We went to the website for Astronauts for America.

We watched a video on SpaceX going to Mars.

We watched a video on space travel. NASA is launching a nuclear-powered mission to Mars.

Nuclear thermal is five times as efficient as conventional chemical rockets. Ion thrusters are ten times as efficient as conventional rockets. NASA is going for nuclear electron propulsion (SR-1). It would take one year to get to Mars.

Kip is going to the ISDC the first weekend in June and won't be back for the June meeting. Adam Hemphill will preside.

We watched an interview with Jared Isaacman. [On the A16 show.]

Space News

On May 28, Blue Origin unveiled its new two-kiloton bomb, which produced a pretty good mushroom cloud over launch pad 36 at Cape Canaveral. This was supposed to be a static fire test of the first stage of *New Glenn*, and caused serious damage to the launch pad that was originally thought to need a year to repair, but now seems to be much less, and may be ready by the end of the year. SpaceX, Blue Origin's rival, thinks it will take longer.

The first stage was completely destroyed and the transporter-erector (the system that moves the rocket to the launch pad and stands it up) was severely damaged and will have to be replaced. Fortunately, no people were injured by the ex-

plosion, the water tower is largely intact, and another first stage, *Never Tell Me the Odds*, and three second stages, which were stored in a nearby building, survived intact.

. The fire (or at least the mushroom cloud) could be seen for miles, and the explosion was loud enough to be heard for a great distance.

Meanwhile SpaceX's *Starship 12*, which was launched on May 22, had its own problems, but they seem less severe. This was a more powerful launcher, and, while the upper stage (*Ship*) performed normally, one of its three large Raptor engines failed after 36 seconds and was out for the rest of the flight. This didn't notably affect the rest of the mission since the remaining two engines were enough.

However, immediately after separation, the first stage's engines went out, probably because of the greater power of the rocket engines on the two crafts. The first stage made an uncontrolled landing with only one of its 32 engines lighting and hit the Gulf of Mexico at about 900 miles per hour. Because of this mishap, *Starship* is grounded for the time being, and *Starship 13* will be a replay of *Starship 12*, hopefully more successful. The first *Starship* orbital flight will now be *Starship 14*, currently scheduled for late this summer, FAA permitting.

Although I haven't changed the dates in "Calendar of Events," Blue Origin and SpaceX are supplying the spacecraft to rendezvous with *Artemis 3* in July 2027, and it seems unlikely that New Glenn, at least, will be ready, given that not only must Blue Origin repair their launch pad, but test *New Glenn* several times to make sure it's ready. The one that goes to *Artemis 3* will be carrying a not entirely functional version of *Blue Moon*, their lunar lander. It seems likely that SpaceX will get their problems solved in time, but they still haven't put *Ship* into orbit (though they can obviously do it) nor demonstrate refueling in orbit (which will be tested this fall).

I'm also keeping the dates for *Artemis IV* (first half of 2028) and *Artemis V* (last quarter of 2028) although these depend on *Artemis III* launching in the second half of 2027 and the success of that mission.

Meanwhile, on June 30 NASA announced the approval of four new lunar missions to launch in late 2028. \$298 million was awarded to Astrobotic for two missions, \$148.3 million to Intuitive Machines, and \$144.2 million to Firefly Aerospace. Each of these will carry these three payloads: SCALPSS (Stereo Camera for Lunar Plume Surface Studies), LRA (Laser Retroreflector Array), and LETS (Linear Energy Transfer Spectrometer). In addition, each of the four spacecraft will carry additional instruments, which are yet to be determined. These extra instruments need not to be identical on all four landers. The LRA sounds interesting as an aid to assisting spacecraft in determining position, especially as they're coming in for a landing, and has the advantage that it uses no power whatsoever. SCALPSS determines the effect spacecraft's rockets have on the lunar surface when the spacecraft is landing. LETS is a radiation environmental monitor to determine how to protect astronauts better; since we never have landed astronauts near the Lunar South Pole, we're looking for unforeseen dangers. With four landers, NASA can cover a variety of landing sites.

Since these contracts are newly awarded and we don't know the names of the four missions, I'm waiting on more exact dates, but fourth quarter of 2028 is what they are aiming for, about the time *Artemis V* is projected to land on the Moon.

After last issue's flurry of Artemis Accords signees, we have only one to report this month: Botswana on June 25. Botswana is the 68th signee and joins Angola, Morocco, Nigeria, Rwanda, and Senegal from Africa. Of these, Botswana is the easily the richest in per capita GDP although Nigeria is far ahead in actual GDP because it is far more populous.

The cover picture on this issue is the Neil Gehrels Swift Observatory, which was launched in 2004 as the Swift Gamma-Ray Burst Explorer. Despite the name, it can also observe burst sites in X-ray and visible light. In 2018, it was renamed after Mr. Gehrels, the long-time head of the project after his death in 2017.

With all the solar activity around 2025, the Swift Observatory's orbit was deteriorating rapidly, with reentry late this year. Thus, MADA hired Katalyst's LINK robotic servicing satellite to capture and boost Swift's orbit. The mission was finally launched on July 3, though it will be several weeks before LINK actually rendezvous with Swift.

This will be a challenging capture because Swift was never meant to be captured or boosted. If successfully captured, it will take months to get to Swift's original orbit, but at least it will stop descending.

TESS is intended to detect exoplanets which transit their stars' disks, which means they are generally pretty close to the stars. However, on July 1, scientists announced that it had revealed another capability: It detected an exoplanet far from its star through gravitational lensing. Not only that, although *TESS*'s usual search range is around 150 light-years,

Gaia23bra b is 40,000 light-years from Earth. About three-quarters of known exoplanets have been discovered by the transit method, while only one twentieth were discovered by gravitational lensing. (I suspect most of the others were detected by Doppler shift in the star's light produced by large planets tugging on their stars.)

Note the name of the star: it was discovered by the *Gaia* spacecraft, which noticed the star flashing but wasn't able to determine what was causing it. The Nancy Grace Roman Space Telescope, which launches on August 30, is designed to detect exoplanets by gravitational lensing, which means we may soon have a good survey of planets which are far from their stars. These will also be targeted by the James Webb Space Telescope. Space exploration is sometimes a collaborative effort by space telescopes.

The Chinese sample return mission *Tianwen-2* arrived at Earth's quasi-Moon **469219 Kamo'oalewa** on July 4, sending back really good photographs of what, sadly, seems to be a nondescript gray rock. However, the composition should be interesting, since it is suspected of having been shot into space from an asteroid impact on the Moon. *Tianwen* will orbit the quasi-moon for nine months before retrieving samples from its surface.

Kamo'oalewa "orbits" the Earth every 45 years, but it might be better said that it is co-orbital since it is 10 – 40 million miles from Earth. It's not gravitationally bound to the Earth and will eventually escape.

Sky Viewing

The next two months feature one minor shower, the **Alpha Capricornids**, one medium-sized shower the **Southern Delta Aquariids**, and one major shower, the **Perseid Meteor Shower**. The first two both peak in late July, with the Southern Delta Aquariids peaking at 4:00 a.m. on July 28 with 25 per hour, and the Alpha Capricornids around the same night with only about five. These showers actually have shallow peaks, and both have radiants in the southern part of the sky (Aquarius and Capricornus are adjacent constellations in the Zodiac), so you can really look for them at the same time. Oddly, though the Alpha Capricornids offer fewer meteors, the ones it has tend to be brighter. This will probably not be a good year for the showers since the Moon is full on July 29.

The Perseids, on the other hand, get up to a hundred meteors per hour. I've seen them from a dark park in the center of Norman, but there's more light pollution now, so I'd advise getting a few miles away from the city. The peak is on the night of August 12 – 13, and the radiant is in the north near Cassiopeia. Viewing conditions are perfect since the New Moon is on the morning of August 12 (which makes the next item possible). The Perseids tend to have larger fragments than many meteor showers, so they tend to be brighter. It's also possible to see meteors a few mornings before and after the peak, so try on the mornings of August 10 through 14.

Also on August 12 is the first **total solar eclipse** of the year, starting in Northern Siberia heading west until it reaches Greenland and Iceland, heading south until it reverses direction, crossing northernmost Portugal, northern Spain, and the Balearic Islands before ending in the western Mediterranean Sea. Our correspondent in Portugal should have a great view. This is the only total solar eclipse this year, the eclipse in February being an annular eclipse.

There is also a **partial lunar eclipse** starting about 9:33 p.m. on August 27. Maximum eclipse is at 11:13 p.m., at which time the Moon will be 96% covered, with only a tiny sliver shining bright. This eclipse will be easily visible from Oklahoma since it takes place close to midnight.

Mercury is in inferior conjunction with the Sun on July 12, and won't become visible until around July 28, at which point it will be visible low in the eastern sky maybe half an hour before sunrise. I would try maybe a week later but really this is a poor apparition. However, Mercury and Jupiter will be close together in the sky in early August with closest conjunction on August 15, so if you can find the brighter Jupiter, Mercury will be just north of it and will itself be magnitude -1.2 while Jupiter is magnitude -1.8. Mercury will disappear soon after as it approaches superior conjunction on August 27.

Venus is magnitude -4.1 and very conspicuous in the west after sunrise. It is growing brighter and higher each night, reaching magnitude -4.3 by July 31 and -4.6 on August 31. Venus is currently crossing Leo but will cross into Virgo on July 31, crossing it through August and having a conjunction with Spica (alpha Virginis) on August 31.

Mars is currently magnitude 1.3 and is currently in Taurus in the Hyades cluster. It is several degrees north of Aldebaran, which is a bit brighter at magnitude 0.9 and somewhat reddish itself. Mars continues across Taurus through July until August 12, when it crosses into Gemini. This means it will be fairly high in the eastern sky at the same time the Perseids are peaking. During all this time, Mars stays about the same brightness.

Jupiter is in conjunction with the Sun on July 29 so it will not be visible during the last two weeks of July or the first ten days of August. It will start to become visible maybe ten days into August, just in time for its conjunction with Mercury. By August 31, Jupiter will be eleven degrees above the horizon an hour before sunrise.

Saturn is currently in Pisces, where it is easily the brightest object at about magnitude 0.6. It is currently rising about midnight, but by July 31, it will be rising at 11:00 p.m., and at the end of September around 9:00 p.m. Not surprisingly, it is approaching opposition to the Sun, which it will reach on October 4. Saturn moves slowly across the constellations (which is why its associated element is lead) and will be in Pisces until it crosses into Cetus for a few weeks in late September and early October.

Uranus is in the constellation Taurus about five degrees (half a fist-width) south of the Pleiades. On July 4, it had a conjunction with Mars, which is still in the vicinity. Uranus will not move much from one night to the next, so if you find it one night, you're set for weeks. To search for Uranus, try <https://lovethenightsky.com/see-uranus-through-a-telescope>

Neptune is currently rising around midnight shortly before Saturn but is not close to it. Unfortunately, the region of Pisces it is in is pretty barren. At magnitude 7.8, Neptune's a difficult object to search for, but <https://lovethenightsky.com/see-neptune-through-a-telescope/> should be a help. Like Uranus, Neptune has a definite blue-green tinge that will help distinguish it from background stars. Even more than Uranus, 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 (July 11 – August 11, 2026)

You can get sighting information at www.heavens-above.com, which gives you a constellation map showing the trajectory of the satellite.

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 in July 2024.

The "mag." beside the date indicates the brightest magnitude the satellite gets during the pass. Most of 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 July 14 Soyuz Mission carrying cosmonauts Pyotr Dubrov and Anna Kakina and NASA astronaut Anil Menon. There are no currently announced flights to *Tiangong* in July or August.

The information below is from Heavens Above. There are no passes of the Hubble Space Telescope that go above 26° and those that go that high are early in the morning.

HST 7/12 mag. 1.6			
	Time	Position	Elevation
5:49 a.m.	240°	10°	
5:52	179	28	
5:55	118	10	

Tiangong 7/19 mag. -1.3			
	Time	Position	Elevation
9:30 p.m.	303°	10°	
9:33	18	47	
9:36	92	12	

HST 7/13 mag. 1.6			
	Time	Position	Elevation
Appears from Earth's shadow.			
5:17:58 a.m.	221°	20°	
5:19:37	179	28	
5:23	118	10	

Tiangong 7/21 mag. -2.1			
	Time	Position	Elevation
9:13 p.m.	295°	10°	
9:16	24	85	
9:19	113	10	

Tiangong 7/18 mag. -2.1			
	Time	Position	Elevation
10:27 p.m.	297°	10°	
10:29:53	23	73	
10:30:11	71	65*	

ISS 7/24 mag. -3.9			
	Time	Position	Elevation
10:24 p.m.	314°	10°	
10:27:04	42	80	
10:27:19	97	72*	

Vanishes into Earth's shadow

Vanishes into Earth's shadow.

*Passes just below Arcturus

*Passes just south of Vega.

HST 7/26 mag. 1.6			
	Time	Position	Elevation
9:44 p.m.	235°	10°	
9:47:22	176	27	
9:48:37	142	22	
Vanishes into Earth's shadow.			

ISS 7/27 mag. -3.2			
	Time	Position	Elevation
9:38 p.m.	303°	10°	
9:40:47	226	53*	
9:43:01	153	19	
Vanishes into Earth's shadow.			
*Passes just south of Arcturus.			

HST 7/27 mag. 1.7			
	Time	Position	Elevation
9:12 p.m.	235°	10°	
9:15	176	27	
9:18	118	11	

Tiangong 8/11 mag. -1.2			
	Time	Position	Elevation
6:02 a.m.	219°	11°	
6:05	149	40	
6:08	78	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 Tiangong space station at 6:05 a.m. on August 11, measure just over three fist-widths east of due south, then just over four fist-widths above the horizon.

Programming Notice: NASA+ on the Web

NASA-TV has become NASA+ [s](#)

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

I don't have a schedule of events, but they will certainly cover the Soyuz launch on July 14 and the launch of the Nancy Grace Space Telescope on August 30.

Calendar of Events

Sometime in 2026: *New Glenn* launch carrying Firefly's *Elytra* orbital transfer vehicle and the *ELaNa-42* mission which will launch 42 cubesats.

Sometime in 2026: Launch of Japan's *Martian Moons Exploration* (MMX) which includes a Phobos lander and sample return. This also is carrying IDEFIX, a Mars Rover built by France and Germany. For information, see [en.wikipedia.org/wiki/Martian_Moons_exploration_\(MMX\)](https://en.wikipedia.org/wiki/Martian_Moons_exploration_(MMX)).

Sometime in 2026: Second (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>. Note: with *Gaganyaan 1* being delayed until the second half of 2026 *Gaganyaan 2* and/or 3 will likely be moved to 2027.

Sometime in 2026: Third (uncrewed) *Gaganyaan* flight test. This one will carry the Vyommitra humanoid robot.

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

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

Sometime in 2026]: Launch of Boeing *Starliner-1*, first operational Starliner mission.

Sometime in 2026: launch of Canadensys Lunar Rover.

Third quarter of 2026 [moved from second quarter]: Launch by Falcon 9 Heavy of MRV which will carry DARPA's robot satellite servicer (RSGS), which will install extension pods to lengthen satellites' lifetimes.

Second half of 2026: First (uncrewed) *Gaganyaan* flight test. For more information, see https://en.wikipedia.org/wiki/Gaganyaan_1.

Second half of 2026: A SpaceX *Nova-C* mission to the Moon takes Intuitive Machines' IM-3 lander, NASA's Lunar Vertex rover, and several NASA Cadre rovers. For information, en.wikipedia.org/wiki/IM-3.

Third Quarter of 2026: Launch of *Starship 14*, the first Starship to enter a circular orbit.

Third Quarter of 2026: Launch of Blue Origin's *Blue Moon* Mark 1 lunar lander. This is one of a number of missions called Pathfinder. Mark 1 is uncrewed; Mark 2 is a few years off but will carry astronauts.

Third quarter of 2026: Maiden flight of Spain's Miura 5 reusable launch vehicle.

Third quarter of 2026: Launch of *RFA One* from SaxaVord Spaceport in the Shetland Islands. If successful, this will be the first orbital flight launched by the United Kingdom after several tries.

July 2026: *Starship 13*. After some problems with *Starship 12*'s first stage, this will be another suborbital test flight.

July 10: 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 for details.

July 11: Oklahoma Space Alliance meeting, 2:00 p.m., Norman Computers. Meeting information will be posted at <http://osa.nss.org>.

July 12: Mercury is inferior conjunction with the Sun.

July 20: 57th anniversary of *Apollo 11* moon landing.

July 28: Jupiter is in conjunction with the Sun.

August: 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.

August 2: Mercury is at greatest elongation, 19.5° west of the Sun (hence can be seen before sunrise).

August 12: Total eclipse of the Sun. This one is on an unusual curve that begins on the north central coast of Siberia, goes over Greenland and Iceland and finally ends by crossing northern Spain and a bit of northern Portugal. This is the first total eclipse in Europe since 2006. Interestingly, the next one is August 2, 2027, and starts in Spain.

August 12: Peak of Perseid meteor shower.

August 15: Venus is at greatest elongation, 45.9° east of the Sun (hence can be seen after sunset).

August 30 [moved up from September 28—it can happen]: 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.

September 25: Neptune is at opposition.

Fourth quarter of 2026 [Moved from July]: Launch of Astrobiotic's *Griffin Mission 1*, including lunar lander, FLIP lunar rover, and CubeRover on a Falcon Heavy. This will land at Nobile Crater near the South Pole of the Moon. For more information, https://en.wikipedia.org/wiki/Griffin_Mission_One.

Fourth quarter of 2026 [Moved from first quarter]: Maiden flight of Rocket Labs Neutron launcher, from Wallops Island, Virginia. For more information, https://en.wikipedia.org/wiki/Rocket_Lab_Neutron

Fourth quarter of 2026 [moved from second quarter]: second *Blue Ghost* mission, carrying *Lunar Pathfinder* to the far side of the Moon. This mission also carries the United Arab Emirates *Rashid 2* rover. *Rashid-1* was lost with the *Hakuto-R* mission in 2024.

Fourth quarter of 2026 In-flight fuel transfer from Starship to a target.

Fourth quarter of 2026: First *Dream Chaser* demonstration mission, not to ISS as originally planned.

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

October 4: Saturn is at opposition.

October 12: Mercury is at greatest elongation, 25.2° east of the Sun (hence can be seen after sunset).

October 21: Peak of Orionid meteor shower. This is the second meteor shower associated with Halley's Comet.

October 23: Venus is in inferior conjunction with the Sun.

November: *Hera* arrives at the binary asteroid Didymos (the one we hit with an impactor). Somehow, this is one month earlier than previously planned.

November: *BepiColombo* enters Mercury orbit.

November 5: Peak of South Taurid meteor shower.

November 12: Peak of North Taurid meteor shower.

November 17: Peak of Leonid meteor shower.

November 20: Mercury is at greatest elongation, 19.6° west of the Sun (hence can be seen before sunrise).

November 25: Uranus is at opposition.

December 14: Peak of Geminid meteor shower.

December 22: Peak of Ursid meteor shower.

Sometime in 2027 [Moved from 2026]: Launch of *Griffin II*, the third lunar lander mission by Astrobiotics, which will land near the lunar south pole.

Sometime in 2027 (moved from 2026): Launch of the *Venus Life Finder Probe and Photon* relay satellite to Venus by RocketLab's Electron Booster for MIT. For more information, visit https://en.wikipedia.org/wiki/Venus_Life_Finder.

Sometime in 2027: Launch of Blue Moon Pathfinder Mission 2, which will carry VIPER to the Moon.

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 *Hab-1*, which it will dock with as part of a free-flying space station.

Sometime in 2027: India launches *Chandrayaan-4*, a lunar sample return mission. For more information, <https://en.wikipedia.org/wiki/Chandrayaan-4>

Sometime in 2027: First crewed mission to Vast's *Haven-1* space station. For information, en.wikipedia.org/wiki/Haven-1.

Sometime in 2027: India launches its first crewed orbital flight *Gaganyaan 4*.

Sometime in 2027: First flight of China's Long March 10 crew launch vehicle, which will carry Chinese astronauts to the Moon.

First quarter of 2027 [Moved from May 2026]: launch of Vast's *Haven-1* space station. For more information, en.wikipedia.org/wiki/Haven-1.

January 2027: Launch of PLATO, (PLANetary Transits and Oscillations of stars—couldn't you just name it Plato and not create a pseudo-acronym?) This is a mission dedicated to finding Earth-sized exoplanets in habitable zones around nearby stars.

January 2027: *Axiom-5*, a four-person fourteen-day mission to the ISS.

January 3, 2027: Peak of Quadrantid meteor shower.

April 2, 2027: Total eclipse of the Sun, beginning off the west coast of Iberia, and crossing the Straits of Gibraltar, including southern Spain, and northern Morocco, Algeria, Libya, north and central Egypt, western Saudi Arabia, Yemen and the tip of the Horn of Africa before ending in the mid-Indian Ocean. This eclipse is dubbed the Eclipse of the Century because it has the second longest period of totality of any eclipse this century and the longest, in 2009, was almost entirely over the Pacific Ocean. Maximum totality is near Luxor, Egypt, though Benghazi and Mecca come close.

April 12, 2027: Yuri's Night. 66th anniversary of humans in space.

July 2027: Launch of *Artemis 3*. This has been changed from a lunar landing to a Near-Earth mission to test out equipment for a Moon landing in 2028. [I suspect this will be later in the year.] 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.

August 20, 2027: 50th anniversary of launch of *Voyager 2*.

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 information, see https://en.wikipedia.org/wiki/NEO_Surveyor.

September 5, 2027: 50th anniversary of launch of *Voyager 1*.

Fourth quarter of 2027 [Moved from 2026]: *Starship* launch of the *Starship HLS* lunar lander and FLEX, Astrolab's demo lunar lander to the lunar south pole. *Starship HLS* is the craft SpaceX will use to transfer astronauts to the Moon.

Fourth Quarter of 2027: Launch of the *ZeusX* Orbiter and lander and *LIBER* (the Lunar Integrated Bulk Extraction Rover). The last is a lunar miner rover. These are being produced by the Singapore-based private company Qosmosys.

Sometime in 2028: Launch of *Luna 26*, Russia's 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 2028: Launch of Habitat One to the Axiom space station.

Sometime in 2028: India launches its second crewed orbital flight *Gaganyaan 5*.

Sometime in 2028: India launches *Gaganyaan-6*, its first resupply mission to the ISS.

Sometime in 2028: India launches *Mars Lander Mission* (MLM 2 or *Mangalyaan 2*). This seems to be the same as MOM2. For more information, https://en.wikipedia.org/wiki/Mars_Lander_Mission

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.

Sometime in 2028 or 2029: 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 *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.

First half of 2028: Launch of *Artemis IV*, which, with the revised launch schedule will be the first manned landing on the Moon since 1972. For more information, https://en.wikipedia.org/wiki/Artemis_IV.

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. This is also called VOM (Venus Orbiter Mission). For more information, see <https://en.wikipedia.org/wiki/Shukrayaan-1>.

April 2028: Launch of JAXA's *DESTINY+*, an asteroid flyby mission to Near Earth Asteroid Apophis and later Phaethon, the parent of the Geminid meteor shower. It will arrive there in 2029. For information, see en.wikipedia.org/wiki/DESTINY%2B. On same launch is the ESA's *Ramses* spacecraft, which will also fly by Apophis. For more information, [https://en.wikipedia.org/wiki/Ramses_\(spacecraft\)](https://en.wikipedia.org/wiki/Ramses_(spacecraft))

Between July 5 – 25, 2028: Launch of *Dragonfly*, the Titan helicopter mission. For information, see [en.wikipedia.org/wiki/Dragonfly_\(spacecraft\)](https://en.wikipedia.org/wiki/Dragonfly_(spacecraft)).

Fourth quarter of 2028: Launch of *Artemis V* to land on the Moon.

Fourth quarter of 2028: Launch of *UUM*, the core module of the *Russian Orbital Service Station*, or *ROS*. For more information, see https://en.wikipedia.org/wiki/Russian_Orbital_Service_Station.

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 2028: JAXA, the Japanese space agency, launches *OPENS-0*, which will fly by the rings of Saturn in 2039.

Sometime in 2029?: First crewed flight to the Russian Orbital Space Station (ROS).

Sometime in 2029: 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 2028's Luna 26 orbiter. For more information, see https://en.wikipedia.org/wiki/Luna_27#Science_payload.

Sometime in 2029: Launch of the *Solar Power Orbit Observatory*, assuming it can find a ride.

Sometime in 2029: *ClearSpace-1* will capture and deorbit *PROBA-1*.

Sometime in 2029: *ESA/JAXA Comet Interceptor* via Ariane 62 to the Sun-Earth L₂ point, where the Interceptor will wait for a long-period comet or interstellar object to come by. [Apparently this and *ARIEL* have been separated.

March 5, 2029: 50th Anniversary of *Voyager 1* flyby of Jupiter.

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.

July 9, 2029: 50th Anniversary of *Voyager 2* flyby of Jupiter.

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 Jupiter and Callisto orbiters 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: Launch of China's *Tianwen-3* Mars sample return mission and orbiter.

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

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

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

April 11, 2030: *Europa Clipper* arrives at Jupiter.

November 12, 2030: 50th anniversary of *Voyager 1* flyby of Saturn.

Sometime in 2031 [Moved from 2029]: Launch of the *ARIEL Space Telescope*.

Sometime in 2031 or 2032: Launch of *DAVINCI*, a NASA Discovery Program mission to Venus.

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

June 2031: Launch of *VERITAS* Venus orbiter. 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, inserts into Jupiter orbit.

August 26, 1981: 50th anniversary of *Voyager 2* flyby of Saturn.

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

Sometime in 2032: Launch of Russia's *LunaGlob* lunar orbiter.

Sometime in 2032: Launch of the first South Korean lunar lander and rover, *KLLR*.

Sometime in 2032: Launch of the pressurized *Lunar Cruiser*, a crewed lunar rover.

Sometime in 2033: Launch of the Foundational Surface Habitat, the first component of the Artemis Base Camp.

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

Sometime in 2034 [Moved from 2030]: Launch of Russia's *Luna 28* sample return mission.

December 2034: *JUICE* achieves Ganymede orbit.

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

21 January 2035: *Tianwen-2* rendezvous with comet 311P/PanSTARRS.

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

Sometime in 2036 {moved from 2031(!)}: Launch of Russia's *Venera-17* Venus orbiter and lander.

January 24, 2036: 50th anniversary of *Voyager 2* flyby of Uranus.

2038 or 2039: Launch of *Chandrayaan-H1*, India's first crewed mission to the Moon (a flyby, not a landing).

Sometime in 2036: *Dragonfly* arrives at Titan.

August 25, 2039: 50th anniversary of *Voyager 2* flyby of Neptune.

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.

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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 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. The 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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