

OKLAHOMA SPACE ALLIANCE

OUTREACH – September 2023

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet at the
at the room next to Norman Computer
at 2:00 p.m. on September 9, details inside

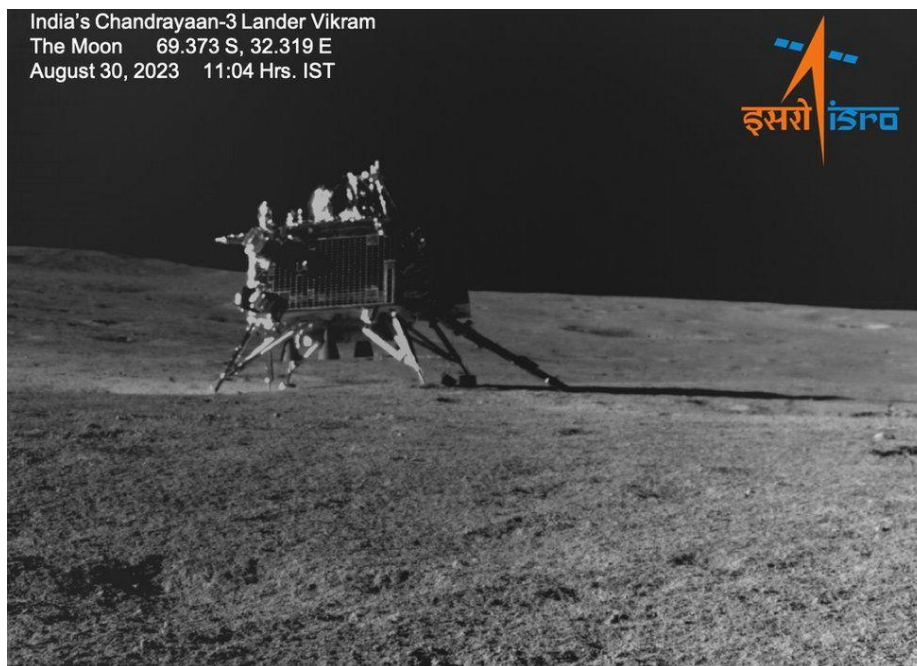


Figure 1A photo of the Vikram lander taken by Pragyaan rover (BBC)

OKLAHOMA SPACE ALLIANCE OUTREACH September 2023

NASA has decided to cut funding for *New Horizons* on October 1, 2024. NSS is cosponsoring a petition to keep the mission funded. *New Horizons* is still making observations in the Kuiper Belt and there are still possible objects for it to encounter. The petition is at <https://www.change.org/p/save-new-horizons-the-pluto-flyby-and-kuiper-belt-exploration-mission-23183a16-ea8e-4663-a614-2383fc23bef8>. The petition closes on September 8, so you have to act now.

September Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, September 9, at the location next to Norman Computers on West Main. Prospective members are welcome.

The meeting room is in the Cyber Hall and Gaming Lounge at Norman Computers. Norman Computers is at 916 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 in a small mall.

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) or Syd Henderson at 405-365-8983 (C) (e-mail sydh@ou.edu) and we will send you updated information.

Saturday September 9, 2023, 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 June meeting
 - c. Posters
 - d. Presentations from ISDC
5. Video (to be announced)
6. Chat

Minutes of August 12 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met August 12, 2023, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending in person were Clifford McMurray, Richard Adkins, Charles ?, Mark Deaver, Adam Hemphill, Kevin?, Steve Marino, Tim Scott, Dave Sheely, and Syd Henderson. 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 <https://osa.nss.org/Update2308.pdf> so I'll cover the details that aren't covered there.

Starship 2 didn't get all 33 engines to light the first attempt since the attempted flight. Four engines did not light. [In a second test last week all engines lit though two didn't stay lit through the six-second test.] The question is how soon they can try a second test flight given the engines problems and an ongoing lawsuit.

The Mars Sample Return mission asked for \$943 million in the new budget but only got \$300 million.

We watched a video of Virgin Galactic's first wholly tourist flights. (The flight in June was more scientific.) Commander was C. J. Sturcknow, Pilot Kelly Latimer, and passengers were Beth Moses, Jon Goodwin, Keisha Schahaff and Anastasia Mayers. Beth Moses is listed as "Astronaut Instructor" and the last three simply as "Tourist.) Sturcknow is a space shuttle veteran. Moses is a veteran of previous Virgin Galactic flights. Keisha Schahaff is Anastasia Mayer's mother. This was the first mother and daughter to fly into space. Mayer is the youngest woman to fly into space.

Virgin Galactic plans to have a launch a month. The next few flights will have three passengers but will go up to four next year.

We watched a video of the launch and landing. They went up to around 291,000 feet, or 55 miles (or a bit over 90 kilometers).

Each vehicle in China's Moon lander will weigh 26 tons, and the forthcoming Long March 10 can carry 27 tons. This means that the vehicle will require two launches and assembly in orbit. China will have ten nations signing up by October 2023.

The next Zhuque launch will be by the end of the year. We watched a video of the *Zhuque-2* launch.

Chandrayaan 3 will land at 70 degrees south latitude on the Moon and will last for one lunar day. We watched the launch of *Chandrayaan 3*.

Russia's *Lunar 25* lander will "sit where no one has ever sat."

Jupiter 2 was lost so the new largest comsat is *Jupiter 3*. We watched a video of the Falcon Heavy launch and the return of the two boosters.

We watched RocketLab launch its Electron booster to orbit.

The European Space Agency wasn't spending money to send astronauts to the ISS but was doing it on a swap basis.

This Week @ NASA: The Nancy Roman Space Telescope could detect as many as 400 "rogue planets" similar in mass to Earth. [A rogue "planet" is one that doesn't orbit a star or brown dwarf. They may have thrown out of their star system or been formed away from a star.]

We have \$896.06 in the bank account and \$267 in cash for \$1163.06 in total.

We are willing to spend up to \$50.00 on posters for OSA. The cost is \$15.00 apiece. We authorized Adam to spend the money.

--Minutes by OSA Secretary Syd Henderson

Minutes of July 8 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met July 8, 2023, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending were Clifford and Claire McMurray., Mark Deaver, Adam Hemphill, John Northcutt, Dave Sheely, and Syd Henderson. 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 <https://osa.nss.org/Update2307.pdf> so I'll cover the details that aren't covered there.

Virgin Galactic can now fly six passengers including pilots. We watched a video of the entire June 29 flight including landing. This was the first Virgin Galactic flight with paying passengers after a test flight in May.

We watched a video of Ecuador and India signing the Artemis accords, the 26th and 27th countries to do so. [India has a substantial space program, so I'm glad to see this addition.]

We watched a video of *BepiColombo*'s flyby of Mercury. Still two and a half years to go before it enters Mercury orbit.

"Hot staging," which SpaceX is planning to use in future Starship flights, means the first stage doesn't completely shut off before the second stage lights up. A side effect of this is that Starship will be able to carry 10% more cargo.

We looked at an article on pulverizing asteroids so they will burn up in Earth's atmosphere.

We looked at an article on EmberCore, a proposed nuclear propulsion system that would make exploration of the outer Solar System more practical.

We examined a proposal to build a radio telescope on the Moon's far side, through the use of *in situ* materials.

We watched a video advertising Zero Gravity concerts. Kip used this as an excuse to replay "Upside Down and Inside Out" by OK Go, which was filmed on the "Vomit Comet".

Space Force wants one hundred and thirty-five satellites.

Projecting the rate at which SpaceX is having to increase its number of avoidance maneuvers in orbit, by 2028 they may have to do 2,000,000 of these per year.

From *This Week @ NASA*: The James Webb Space Telescope has detected the most distant known supermassive black hole. It has also detected methyl cations (*i.e.*, CH₃⁺.)

The *Orion* space capsule will test laser communication on *Artemis 2*.

We watched a video "A New Golden Age of Space" with John Gedmark."

https://www.youtube.com/watch?v=T24qG99_wVw

Adam has created a poster for OSA meetings. We did a critical appraisal and will continue at the next meeting.

--Minutes by OSA Secretary Syd Henderson

Space News

See "Sky Viewing" for information about the October 14 annular solar eclipse.

Marilyn Lovell died of natural causes August 27 at age 93 and is survived by her husband. She of course got to see her husband go to space on Apollo 8 and 13. After the latter he understandably retired. Marilyn Lovell was portrayed in *Apollo 13* by Kahleen Quinlan, who got a supporting actress nomination at the Oscars for the role.

Mount Marilyn on the Moon is named for her.

The brown dwarf WD 0032-317 B has a surface temperature of 14,000°F, which is four thousand degrees hotter than the Sun. At first glance, this seems impossible since brown dwarfs don't have fusion reactions (other than burning lithium or deuterium, which would have run out for this brown dwarf). The explanation lies in the "WD: in its name. It is in a close orbit around a white dwarf (WD 0032-317, naturally), and although white dwarfs are dim, that is only because of their small size. This one has a surface temperature of around 66,000° F, which is hot even for a white dwarf. Its brown dwarf companion orbits once every 2.5 hours and is tidally locked, hence the extreme heat from the radiation of the star. The brown dwarf is very large near the limit of being a star and is tidally locked, so the night side is a relatively cool 3600°F. Its size is probably the key to it surviving the stars red giant phase, although I suspect it may have been pulled in from a more distant orbit.

In January 1959, the Soviet Union launched the first moon probe *Luna 1*, with the intention of impacting it on the Moon. They managed to miss the Moon, but in the process, *Luna 1* became the first spacecraft to achieve heliocentric orbit, albeit unintentionally. As far as anyone knows, it's still orbiting the Sun.

Luna 25 is the first spacecraft in Russia's return to the Moon, and this time it did impact the Moon, though it was supposed to make a soft landing. This was a result of an orbital maneuver that put it in an orbit that intersected the surface of the Moon. Apparently, the culprit was an engine that refused to turn off, burning for 127 seconds instead of 84 seconds, and that was sufficient to cause a hard landing four hundred miles from the intended landing spot. *Luna 25* was Russia's first lunar probe in 47 years, so its loss is a big blow.

The next Russian lunar lander, *Luna 26* won't be until 2027. The exact date will probably be announced after more analysis of the crash and a few firings of selected personnel.

Chandrayaan 3, on the other hand, is a rousing success, making India the fourth nation to make a soft landing on the Moon. This is India's third lunar exploration mission.

The first, *Chandrayaan 1*, was a Moon mapping mission that included the Moon Impact Probe which intentionally crashed into Shackleton Crater near the Moon's South Pole and confirmed the presence of water ice there. The orbiter functioned for ten months, mapping much of the lunar surface to high resolution. The mission was supposed to last two years but still achieved its objectives.

Chandrayaan 2 consisted of an orbiter, lander and rover. The orbiter is still functioning and is expected to last until 2026. The lander (*Vikram*) and rover (*Pragyan*)—*Chandrayaan 3*'s lander and rover have the same names—made an unintentional crash landing less than a kilometer from the intended landing spot and about ten degrees west of the landing spot of *Chandrayaan 3*'s lander and rover. (If my calculations are correct, that's about a distance of 65 miles almost due west.) The orbiter continues to map the lunar surface, look for ice, and probe the Moon's crust with radar.

Chandrayaan 3 was launched on July 14 and achieved lunar orbit on August 5. After several orbits during which the orbiter lowered and circularized its orbit to an altitude of about 100 miles above the lunar surface, *Chandrayaan 3* release the *Vikram* lander and *Pragyan* rover on August 18, and they landed on August 23 at 9:05 UTC (4:05 CDT). The landing site, Shiv Shakti Point, is at 69.373°S and 32.319° and, although it is described as being near the Lunar South Pole, it is in fact about 390 miles away. The equivalent latitude North on Earth would place it about 150 miles south of Point Barrow, Alaska. (Shackleton Crater, where the Moon Impact Probe hit, is exactly on the Lunar South Pole.)

The landing location was chosen to maximize the amount of time the lander would be in sunlight and also get enough power to function through the lunar day. As such, *Vikram* and *Pragyan* were only intended to function from sunrise to sunset, i.e., August 19 – September 3. Although lunar sunrise may revive them around September 22, this would be gravy. They were only intended to function until the first sunset. They are now in sleep mode.

Both *Vikram* and *Pragyan* functioned very well. *Vikram* is analyzing the composition of the rocks and soils at the landing site. It also found that a temperature was 122°F at the surface while only 14° F a tenth of an inch below, suggesting that the lunar regolith at this spot is a very good heat insulator (which actually means water ice may eventually be detected under the surface). The reason the temperatures are lower than during the *Apollo* missions is, after all, this is the Lunar latitude equivalent of the Antarctic Circle, though it clearly doesn't have the midnight sun as on Earth. The title of the Moon's axis is only 1.5°, which means that the Lunar Antarctic is only three degrees in diameter.

On September 2, India launched its first solar observatory, *Aditya L-1*, from Satish Dhawan Space Centre aboard a Polar Satellite Launch Vehicle. As the name suggests, *Aditya L-1* is destined for the Sun-Earth L-1 point, which is the go-to place for solar observations since the Earth and Moon are behind it, so no eclipses. It will take about 127 days for it to reach its destination, so expect it to arrive during the second week in January. (I've seen some contradictory information that it will arrive in late December. Perhaps it takes some time to achieve its halo orbit after it arrives at L-1.)

. (For similar reasons, if you want to observe the sky in the opposite direction, you send your space telescope to L-2, like *Gaia*, *Euclid* and the *James Webb Space Telescope*.) The name *Aditya* means "sun" in Sanskrit. Indian spacecraft names tend to be simple in translation.

The duties of this space craft including solving the coronal heating mystery and energetic solar events such as coronal mass ejections and solar flares,

Incidentally, the price tag for the *Chandrayaan 3* spacecraft is about \$90 million US and *Aditya L-1* is \$46 million US. [I doubt that includes the cost of the rocket, but I could be wrong.]

Kuiper Belt Object 2002 MS4 has an impact crater 27 miles deep and 200 miles in diameter, which is rather astonishing for an object only five hundred miles in diameter. If so, this may preclude it being designated as a dwarf planet since it wouldn't be round. Incidentally, this is one of the two largest Kuiper

Belt Objects not to have a proper name and the IAU is open to suggestion. I would suggest Ymir, the Frost Giant from whose body the Earth was formed (and incidentally the grandfather of Odin, which means Loki is indeed a relative of Odin). A satellite of Saturn is already named Ymir, but I believe the same name can be used for a dwarf planet.

Kuiper Belt Objects are named for creation deities from all cultures. You'd think they'll run out after a couple of thousand.

Sky Viewing

The big event in the sky during the period covered by this issue of *Outreach* is the **annular eclipse of the Sun** on October 14. This event is being overshadowed by next April's total eclipse since both will be at least partial over all of North and Central America. However, this one is either annular or partial over all South America as well.

Annular eclipses happen when the Moon is new and near apogee. (The Full Moons immediately before are so-called "Super Moons" since the Moon is near perigee for each. This year the Full Moons happen to be the Harvest and Hunter's Moons.)

The path of annularity, along which the edge of the Sun will appear to be a ring around the dark New Moon) crosses both Americas on a diagonal, arriving on the West Coast around Eugene, Oregon, clipping northeast California, then crossing northern Nevada, central Utah, the Four Corners, diagonally across New Mexico, then Texas from Odessa to Corpus Christi. Until it reaches New Mexico, this route is impressively devoid of major cities, but in the last part it reaches Albuquerque (almost exactly in the center of the path), Roswell, and the largest of all, San Antonio. Coincidentally, San Antonio is also going to be on the path of next year's total eclipse. I may have to relocate.

After crossing the Gulf of Mexico, the path crosses the Yucatan before taking trip straight down the east coast of Central America before it crosses the Gulf of Panama before crossing central Colombia and northern Brazil while carefully avoiding all the other countries of South America. Oddly, the amount of open ocean crossed by this eclipse is very small.

Although you can only see the full ring along this path, this eclipse is some 78% total from Oklahoma, which, considering it's about 90% total along the path, is pretty darn good. Peak eclipse will be around 11:45 but the eclipse will last about an hour before and after that. As usual, don't stare at the Sun without protection, although the ring of fire will be bright enough to serve as its own warning.

I always like to view partial eclipses when the light shines between the spaces between leaves. Not at the sun, but at the ground because the spaces act as pinhole cameras and you can see the multiple little eclipses before you.

Since the Moon is busy eclipsing the Sun at mid-month, this makes a perfect opportunity to seek out the **Orionid Meteor Shower**. Actually, these peak a week later than the eclipse, but the first-quarter Moon sets well before peak viewing hours. The Orionids are a respectable meteor shower with up to twenty meteors per hour radiating from a point between Betelgeuse and Alhena, which I always think of as the third star in Gemini. Technically, this is in Orion's club, but it is close to the foot of one of the Twins (Pollux in this case).

The Orionids are one of two meteor showers shed from Halley's Comet. The others are the Eta Aquariids in May, which, despite having to share their constellation with other meteor showers, is more impressive than the Orionids.

Mercury was in inferior condition with the Sun on September 6 and is currently lost in the twilight at dawn. However, it moves quickly and by September 20 will be magnitude 0 and rising ninety minutes before the Sun. Greatest elongation is 18° on September 22 but Mercury continues to brighten, eventually reaching magnitude -1.0 on September 29, but is only ten degrees above the horizon a half-hour before sunrise. (It is directly below Venus.) This is the best morning apparition for Mercury this year.

Mercury will reach superior conjunction on October 19 and become an evening star late in the month, but it will also be much lower on the horizon.

Venus was in inferior conjunction with the Sun on August 13 and is beginning to appear low in the morning sky. Since it is magnitude -4.6, it will stand out if the horizon is reasonably clear. Unlike Mercury, Venus is brightest when it appears as a crescent, and will reach its peak brightness of -4.8 on September 9. However, since it will be higher in the sky each night, its light will have less air to pass through and it will appear even brighter for a few weeks. On October 10 and 11, Venus will be in Leo close to Regulus and the crescent **Moon**. Regulus is the bright star in between which is being dominated by its temporary neighbors. If you can see the curve of stars on the other side of the Moon, you're looking at the Sickie asterism which is the mane of the Lion. Venus will dominate the morning sky for the rest of the year.

Mars is lost in the twilight at sunset as it approaches its conjunction with the Sun on November 17. Since it takes two years to make a circuit of the sky, it will be lost in the Sun until mid-winter at the least, much longer than the other planets are hidden.

Jupiter, on the other hand, is dominant throughout the morning and is high in the south at sunrise. It's shining at magnitude -2.6 in the inconspicuous constellation Aries. Jupiter has two conjunctions with the Moon in October, on October 1 and 28, and the Moon is full both nights. Jupiter is currently rising about 10 pm, but a couple of hours earlier each month and by late October Jupiter will be shining all night long. Opposition is November 2.

Saturn was at opposition on August 27, and it is shining all night right now. It is magnitude 0.4, which is quite conspicuous, especially since Aquarius isn't a bright constellation. The closest first magnitude star is Fomalhaut, which is itself the most isolated first-magnitude star. Saturn can get a half-magnitude brighter than this, but its rings are currently at a shallow angle from our point of view. Saturn will be easy to spot for the next three or four months.

Uranus is joined in Aries by Jupiter. This is a rather dim region of the sky, and Uranus is magnitude 5.8, so it may be difficult to locate (though it is at least as bright as stars close to it in the sky). It's about seven degrees east of Jupiter but only visible under the darkest of skies. To search for Uranus, try <https://lovethehightsky.com/see-uranus-through-a-telescope/>

Neptune is magnitude 7.8 and rising around midnight. It's located just on the Pisces side of the border with Aquarius. It is located south of the Circlet asterism in Pisces. To search for Neptune, try <https://lovethehightsky.com/see-neptune-through-a-telescope/>.

Viewing Opportunities for Satellites (September 9 – October 13, 2023)

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

With the addition of the solar panels, the International Space Station can be as bright as magnitude -4.0 making it brighter than all the stars other than the Sun and all the planets other than Venus, although magnitude -2 to -3 is more likely. The Hubble Space Telescope can get up to magnitude 1.5, which is brighter than the stars in the Big Dipper, but magnitude 2.0 – 2.5 is more likely. *Tiangong* is the Chinese Space Station. It currently gets up to magnitude -2.3 after the addition of the Wentian module last July.

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 next crewed mission to the ISS will be on September 15. After that, there are no missions to the ISS until November 1. There will be a crewed mission to *Tiangong* in October but there's no date yet. There will be none to Hubble in the near 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.

Note that on October 10 and October 12, the Hubble Space Telescope and Tiangong will be in the sky at the same time. In fact, on October 12, they visit Saturn within a couple of minutes of each other. Since Tiangong will be a couple of magnitudes brighter it will be more impressive.

The information below is from Heavens Above. The Hubble Space Telescope passes usually repeat five or six times with similar trajectories and 10 – 15 minutes earlier each day, to about 30 degrees above the horizon. I quit on October 12 because it will be too much in twilight, but it may still be visible.

ISS 9/10/23 mag. -3.7		
Time	Position	Elevation
Appears from Earth's shadow.		
5:35:23	327°	47°
5:36:12	41	76
5:40	128	10*

*Passes very close to Sirius.

ISS 9/12/23 mag. -3.2		
Time	Position	Elevation
8:36 p.m.	202°	10°
8:38:50	133	87
8:40:41	75	20

Vanishes into Earth's shadow.

ISS 9/13/23 mag. -2.1		
Time	Position	Elevation
9:24 p.m.	258°	10°*
9:26:44	324	33
9:27:48	1	26

Vanishes into Earth's shadow.

*Passes very close to Arcturus

ISS 9/14/23 mag. -3.3		
Time	Position	Elevation
8:35 p.m.	238°	10°
8:38	319	60
8:41	41	10

Tiangong 9/18/23 mag. -2.2		
Time	Position	Elevation
6:44 a.m.	294°	10°
6:47	206	85
6:50	117	10

Tiangong 9/29/23 mag. -2.2		
Time	Position	Elevation
7:59:30 p.m.	237°	10°
8:02:35	153	69
8:05:01	71	15

Vanishes into Earth's shadow.

Tiangong 10/1/23 mag. -2.0		
Time	Position	Elevation
7:32 p.m.	252°	10°
7:35	237	70
7:38	52	10

ISS 10/2/23 mag. -3.8		
Time	Position	Elevation
8:27 p.m.	318°	10°
8:30:47	40	63
8:31:28	94	49
Vanishes into Earth's shadow.		

HST 10/09/23 mag. 2.0		
Time	Position	Elevation
8:05 p.m.	232°	10°
8:08:51	172	28
8:10:41	131	20

HST 10/10/23 mag. 2.0		
Time	Position	Elevation
7:50 p.m.	235°	10
7:53:12	174	29
7:55:57	120	14
Vanishes into Earth's shadow.		

Tiangong 10/10/23 mag. -2.2		
Time	Position	Elevation
7:50 p.m.	297°	10°
7:52:59	23	75
7:55:02	107	19
Vanishes into Earth's shadow.		

HST 10/11/23 mag. 2.0		
Time	Position	Elevation
7:34 p.m.	238°	10
7:38	176	30
7:41	114	10°*

*Passes below Saturn

HST 10/12/23 mag. 2.0			Tiangong 10/12/23 mag. -1.9		
Time	Position	Elevation	Time	Position	Elevation
7:18 p.m.	240°	10	7:21 p.m.	290°	10°
7:22	178	31	7:24	208	66
7:25	115	10	7:27	125	10*
*Passes below Saturn			*Passes very close to Saturn		

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 view the International Space Station at 8:38 p.m. on September 14, measure four fist-widths south of due west (or five west of due south), then six 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>. The current live event schedule only goes to September 14, but surely the arrival of a Russian crew on September 15 will be covered.

Calendar of Events

Sometime in 2023: Launch of ADRAS-J, a space debris removal demonstration by Aeroscale Japan.

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

September (maybe): Second orbital test flight of SpaceX's *Starship* spacecraft.

September 8: 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.

September 8 - 16: Okie-Tex Star Party, Camp Billy Joe, Kenton Oklahoma, Kenton, OK. The Oklahoma City Astronomy Club is one of the groups sponsoring this. See www.okcastroclub.com for details. Kenton is in Cimarron County at the western end of the Oklahoma Panhandle.

September 9: Oklahoma Space Alliance meeting, 2:00 p.m., Norman Computers. Meeting information will be posted at <http://osa.nss.org>.

September 15: Expedition 69/70 launch by Soyuz from Baikonur Cosmodrome. Commander is Oleg Kononenko (Roscosmos on his fifth mission), and Flight Engineers are Nikolai Chub (Roscosmos) and Loral O'Hara (NASA), both on their first flight.

September 19: Neptune is at opposition.

September 22: Mercury is at greatest western elongation, 17.9 degrees from the Sun (so can be seen before sunrise).

September 24: *OSIRIS-REx* returns samples from Asteroid Bennu. After this, OSIRIS-REx be renamed *OSIRIS-APEX* (all capitals!) under which name travel to the Near-Earth Asteroid Apophis, which it will reach in 2029.

Fourth Quarter of 2023 [Moved from September]: Launch of *Polaris Dawn* flight carrying Jared Isaacman and four other civilians into space. https://en.wikipedia.org/wiki/Polaris_Dawn

Fourth Quarter of 2023: Launch of *Eris*, the first Australian rocket to launch an Australian payload, and the first launch from Bowen Orbital Spaceport in Queensland, Australia. *Eris* is the launch vehicle for Gilmour Space. For more information, visit en.wikipedia.org/wiki/Gilmour_Space_Technologies#Eris.

October: Sixth crewed flight to the Tiangong space station.

October: Third launch attempt of North Korea's orbital launch craft Chöllima 1

October 5: Launch of *Psyche*, which will orbit a large metallic asteroid also named Psyche. See [en.wikipedia.org/wiki/Psyche_\(spacecraft\)](https://en.wikipedia.org/wiki/Psyche_(spacecraft)). The *Janus* binary asteroid mission, which was to be launched on the same rocket, has been indefinitely postponed.

October 14: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Norman Computers. Meeting information will be posted at <http://osa.nss.org>.

October 14: Annular eclipse of the Sun. 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 19: Mercury is in superior conjunction with the Sun.

October 20: Peak of Orionid meteor shower.

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

November 2: Jupiter is in opposition to the Sun.

November 5: Peak of South Taurid meteor shower.

November 5: Launch of China's *Einstein Probe* X-ray satellite.

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

November 11 – 12: Peak of Northern Taurid meteor shower.

November 12: Peak of North Taurid meteor shower.

November 13: Uranus is at opposition.

November 15 [moved from September after being moved from June]: Launch via Falcon 9 of the *Nova-C* lander and other cargos to the Lunar South Pole. For more on *Nova-C*, see <https://en.wikipedia.org/wiki/Nova-C>

November 17: Mars is in conjunction with the Sun.

November 17 – 18: Peak of Leonid meteor shower.

December [moved from July after being moved from June after being moved from December 2022]: Launch of the *Peregrine* lunar lander by ULA's Vulcan Centaur for Astrobotic Technology. This is the maiden flight for Vulcan Centaur.

December 4: Mercury is at greatest eastern elongation, 21.3 degrees from the Sun (so can be seen after sunset).

December 13 – 14: Peak of the Geminid meteor shower. Often the best shower, the Geminids will be even better since the Moon is practically New.

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

Sometime in 2024: Launch of *Hakuto-R* mission 2, Japan's lunar lander and rover. For more information, see en.wikipedia.org/wiki/Hakuto.

Sometime in 2024: First launch of Firefly's *Blue Ghost* lunar lander delivering payloads to Mare Crisium. For more information, see https://en.wikipedia.org/wiki/Firefly_Aerospace#Blue_Ghost_lunar_lander.

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 information, see en.wikipedia.org/wiki/DESTINY%2B.

Sometime in 2024: India launches Mars Orbiter Mission 2 (MOM 2). For information, see https://en.wikipedia.org/wiki/Mars_Orbiter_Mission_2.

Sometime in 2024 (moved from 2023): First flight of Blue Origin's *New Glenn* orbital rocket.

Sometime in 2024: Maiden flight of the Aurora rocket. This will be the first orbital launch from Spaceport Nova Scotia.

Sometime in 2024 (postponed from 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.

First quarter of 2024: 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.

First quarter of 2024: First ISS Cargo Resupply mission for Dream Chaser.

First quarter of 2024: Launch of China's Queqiao-2, the relay satellite for the *Chang'e-6* mission to the far side of the Moon.

First quarter of 2024: First (uncrewed) *Gaganyaan* flight test. For more information, see https://en.wikipedia.org/wiki/Gaganyaan_1

First Quarter in 2024: Maiden flight of Ariane 6. More precisely, Ariane 64. An Ariane 62 launch will also occur in the first half of 2024.

January 2024 [moved from November 2023]: Launch of *Axiom-3 (Ax-3)* mission to the ISS, via Falcon 9. This carries one professional astronaut and three private astronauts. For more information, see https://en.wikipedia.org/wiki/Axiom_Space.

February 2024: Crew-8 launches to the ISS via Falcon 9.

March 2024 [Moved from 2023]: First crewed test launch of *Boeing Starliner-1* to the ISS. For more information, see https://en.wikipedia.org/wiki/Boeing_Starliner.

March 1, 2024: Final launch of the Delta IV Heavy rocket, and the final launch of a Delta rocket, period. This ends nearly 64 years of flights of the Delta Rocket family.

Second 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: Second uncrewed *Gaganyaan* test flight.

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: Launch of *Chang'e 6*, China's second lunar sample return mission, this time to the Apollo Basin on the far side of the Moon. For more information, see https://en.wikipedia.org/wiki/Chang%27e_6

May 23 – 26, 2024: International Space Development Conference 2024 in Los Angeles, California.

Mid-2024: 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.

Summer 2024 (maybe): First operational flight of Boeing's Starliner 1.

August 6 - 15: *ESCAPADE Blue* and *Gold Mars Orbiters* launch by New Glenn. For more information, see <https://en.wikipedia.org/wiki/EscaPADE>.

September 2024: 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)).

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

Fourth quarter of 2024 (moved from 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.

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/Dimorphos 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,

November 2024 (moved from May): *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.

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 Nobile Crater at Moon's South Pole. VIPER is landing aboard Astrobotic's *Griffin* lunar lander. They leave Earth on 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 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: India launches its first crewed orbital flight *Gaganyaan-3*. For more information, <en.wikipedia.org/wiki/Gaganyaan>.

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

Sometime in 2025 [moved from 2024]: Israel launches its *Beresheet 2* lander and orbiter to the Moon. For more information, see en.wikipedia.org/wiki/Beresheet_2.

Sometime in 2025: 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 2025: first crewed mission to Vast's *Haven-1* space station. For more information, <https://en.wikipedia.org/wiki/Haven-1>.

Sometimes 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: Launch and landing of Japan/India LUPEX lunar lander. For more information, see https://en.wikipedia.org/wiki/Lunar_Polar_Exploration_Mission.

First quarter of 2025: (moved from 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. For more information, see https://en.wikipedia.org/wiki/Mission_Extension_Vehicle.

January 2025 (tentative?): Launch of the Venus Life Finder Probe and Photon relay satellite to Venus by RocketLab.

January 2025: OSAM-1 will rendezvous with Landsat 7 and refuel it. For more information, see <https://en.wikipedia.org/wiki/OSAM-1>

February 1, 2025: Launch of IMAP heliophysics probe and Solar Cruiser to the Earth-Sun Lagrangian point (the one between us and the Sun).

May 2025: Launch of Tianwen-2 (formerly Zheng He), China's asteroid sample return mission and comet orbiter. For more information, see <https://en.wikipedia.org/wiki/Tianwen-2>.

Fourth quarter of 2025: Launch of the Space Entertainment Enterprise's SEE-1 inflatable space habitat docked to the Axiom segment of the ISS. If all else goes well, this will be launched on New Glenn.

December 2025: Launch of *Artemis 3*, which will be the first crewed lunar landing since 1972. For information, see en.wikipedia.org/wiki/Artemis_3. (This will likely be postponed to 2026.)

December 2025: *BepiColombo* arrives at Mercury orbit.

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

Mid 2026: Launch of Starship HLS Lunar lander and Astrolab's FLEX Lunar rover to the South Pole of the Moon.

July 2026: *Hayabusa 2* flies by asteroid 2001 CC₂₁.

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

October 2026: 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.

Sometime in 2026 [Maybe]: Launch test of China's Long March 10, which will eventually carry Chinese astronauts to the Moon.

Sometime in 2027: 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.

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

June 2027: Launch of *Dragonfly*, the Titan helicopter mission. For information, see [en.wikipedia.org/wiki/Dragonfly_\(spacecraft\)](https://en.wikipedia.org/wiki/Dragonfly_(spacecraft)).

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: 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 Chang'e 8, which will include a lander, rover and a 3D printing experiment using lunar resources.

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.

First half of 2028 (postponed from 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.

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.]

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

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

November 2028: Launch of China's *Tianwen-3* 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 (moved from 2028): Launch of *VERITAS* orbiter and Venus Atmosphere Sample Return Mission to Venus.

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)).

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

June 2029: Launch of *DAVINCI+* to Venus. For more information, see <https://en.wikipedia.org/wiki/DAVINCI>

September 2029: Launch of *Artemis 5* to the Moon.

October 2029: *Juice* achieves Jupiter orbit.

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

Sometime in 2030: Launch of *Tianwen-4*, which includes a Jupiter orbiter and a mission to Uranus. For more information, see <https://en.wikipedia.org/wiki/Tianwen-4>.

September 2030: Launch of *Artemis 6* to the Moon.

September 2031: Launch of *Artemis 7* to the Moon. This will include the crewed Lunar Cruiser rover.

Sometime in 2032 [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).

Sometime in 2032: 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.

December 2034: *Juice* achieves Ganymede orbit.

Sometime in 2035: Launch of India's first space station.

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 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. 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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