

OKLAHOMA SPACE ALLIANCE

OUTREACH – May 2024

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 May 11, details inside



ISDC 2024 Logo. For more information, see “Space News” inside.

OKLAHOMA SPACE ALLIANCE OUTREACH May 2024

May Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, May 11, 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 of a small mall.

Saturday May 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 March and April meetings
 - c. Annual Report
 - d. Posters
 - e. ISDC 2024
5. Video (to be announced)
6. Chat

Minutes of April 13 Oklahoma Space Alliance

Oklahoma Space Alliance met April 13, 2024, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending were Adam Hemphill, Claire and Clifford McMurray, Mark Deaver, Steve Marino, and Syd Henderson. OSA President Adam Hemphill presided over the meeting He presented an *Update* put together by Clifford McMurray discussing links to material covered in the meeting and this is online at <https://osa.nss.org/Update2404.pdf> so I'll cover the details that aren't covered there.

April 13 is the day after Yuri's Night, so we started an hour early to have a chance to celebrate.

Steve told us that he is moving to Portugal in May via cruise ship via Florida. I warned him about kraken but not the Bermuda Triangle.

Chang'e 6 is gathering samples from the far side of the Moon.

The Japanese are developing a pressurized lunar rover. An unpressurized rover has options of several rockets capable of carrying. A larger, pressurized rover needs to be more particular in what rockets are used.

The recently retired Delta IV costs \$400 million per launch.

Falcon Heavy will have payloads put in while lying on its side, then made vertical. Delta IV had to load vertically.

ULA is still not quite competitive with SpaceX, but its Vulcan launcher makes it close.

India's prototype spaceplane is Pushpak and successfully carried out its second RLV landing experiment (RLV-LEX-02). [RLV being Reusable Launch Vehicle and LEX landing experiment. They also use HEX for Hypersonic Flight Experiment, REX for Return Flight Experiment and SPEX for Scramjet Propulsion Experiment. They also have OREX, the Orbital Return Flight Experiment. They're ambitious.--Syd] We watched a video of the landing.

The *Rosalind Franklin* Mars rover will now use an American launcher and ESA platform. [This was original supposed to use a Russian platform but that became impossible after Russia invaded Ukraine.--Syd]

Sierra Space aims to land critical supplies anywhere on the planet within 90 minutes of when it was requested.

Time moves more rapidly on the Moon due to lower gravity. It takes about fifty years to get a one second offset. So be prepared to synchronize your atomic clocks! [This is going to actually be a problem with time dilation, and gravitational time shift, so we need to establish our Star Dates now!-Syd]

We chose to celebrate with snacks and a movie. The movie was *The Martian*, which is still a lot of fun to watch.

--Minutes By OSA Secretary Syd Henderson

Minutes of March 9, 2024, Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met March 9, 2024, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending were Adam Hemphill, Clifford McMurray, John Northcutt, Dave Sheely, Tim Scott, and Syd Henderson. OSA President Adam Hemphill presided over the meeting He presented an *Update* put together by him and Clifford McMurray discussing links to material covered in the meeting and this is online at <https://osa.nss.org/Update2403.pdf> so I'll cover the details that aren't covered there.

The end of the Ingenuity Mars Helicopter may have been due to navigation. [They were testing maneuvers for future Mars helicopters.]

We got a picture of the broken strut on the *Odysseus* moon lander. Landing used optical sensors not lidar.

Kip: If we had launched fifty *Apollo* missions to land on the Moon, we would have doubled the Moon's atmosphere,

We watched a video of *SLIM* on the Moon.

First Chinese crewed landing on the Moon will be in 2030 on the near side. We viewed an article on China's Moon landing plans.

While discussing India's future crewed space missions we noted that apparently India has not had an astronaut on either American or Russian missions. [This is incorrect. Rakesh Sharma was on Soyuz T-11 in 1984. Kalpana Chawla, who flew on two shuttle missions, including the fatal *Columbia* mission was born in India but was an American citizen.]

Adam: OSAM has a pretty big projected cost: 2 billion for a mission that will probably be done commercially.

We watched a video of Japan's H3 launch.

Apparently the problem with the Varsa landing license is that the FAA had never issued one to a commercial agency before. We watched the Varda reentry (from cameras in the interior of the craft.)

Eight percent of the mass of Dimorphos was redistributed after the DART impact.

Business: Syd needs to send a report to NSS after each meeting.

We have \$841.73 in the checking account and \$267 in cash for a total of \$1008.73.

April 13 meeting is the day after Yuri's night. We will meet an hour early and bring snack food.

--Minutes by OSA Secretary Syd Henderson

Space News

The 2024 International Space Development Conference (ISDC) is Thursday, May 23 through Sunday, May 26 at the Sheraton Gateway Los Angeles Hotel in Los Angeles, California. Website is <https://isdc.nss.org/>, where you can register for the Conference and Hotel. Some preliminary events take place on May 22, including a tour of Griffith Observatory. Also preceding the ISDC are the 2024 Space Solar Power Symposium and the 2024 Space Tourism Conference, both on Wednesday, May 22 at the same hotel. The Solar Power Symposium continues through the first two days of the ISDC. The Space Tourism Conference appears to have a separate registration from the ISDC.

The Robert A. Heinlein Memorial Award will be awarded at the ISDC to William Shatner, star of *Star Trek*, the original series, and the first series of *Star Trek* movies. He is also an Emmy-winning actor for playing Denny Crain on *Boston Legal*, and an authentic space visitor thanks to *Blue Origin*. If you accept that as making him an astronaut, he became, at 90, the oldest person ever in outer space. Shatner is also the co-author with Ron Goulart of a series of *Tek War* novels and sole credited author of the *Quest for Tomorrow* series and is author or co-author of numerous *Star Trek* novels and books about *Star Trek*. He has also done surprisingly many albums in his unique singing style.

Liftoff for Boeing Starliner-1 Crew Flight Test, the first crewed flight of the Boeing spacecraft, was scrubbed two hours before its scheduled launch at 9:34 p.m. on May 6 due to a problem with an "oxygen relief valve on the Centaur Stage on the Atlas V," according to NASA. Note that Centaur has had over a hundred successful launches, so hopefully this problem may be fixed in a few days, perhaps by the time you read this.

This is not considered a full mission for some reason, though it will carry two astronauts to the ISS, and they will stay for a week. Butch Wilmore is the commander and Suni Williams is the pilot. This will be Wilmore's third spaceflight to the ISS, the first being on *Atlantis* in 2009, where he was the pilot, and Soyuz TMA-14M in 2014. Suni Williams flew to the ISS aboard *Discovery* in December 2006 and returned on June 22, 2007. She was again launched in July 2012 on a Soyuz and returned in November. At one time, she held the record for longest time in space for a woman, and most spacewalks and spacewalk time for a woman.

Incidentally the Starliner capsule on this voyage is named *Calypso*.

The first Boeing Starliner flight considered to be fully operational is Boeing Starliner-1, planned for early 2025 if the crewed test goes well..

Chang'e 6 was successfully launched on a mission to the far side of the Moon on the evening of May 3 EDT (morning of May 4 in China). If successful, this will be the second probe to make a soft landing on the far side of the Moon, and the first to bring samples back from the far side. (Chang'e 5 and all other lunar sample returns missions landed on the near side.) The landing site is about 43 degrees south, within the Apollo Basin, which is a large impact crater. This landing site is about twenty degrees east of the landing site of Chang'e 4. That mission discovered that the rocks in that region and also in the Apollo basin are quite different from those on the near side, probably due to the enormous impact that produced the South Pole-Aitken crater which dominates the southern half of the region below 40 degrees south on the far side. It isn't clear to me whether the Apollo Basin is considered part of the South Pole-Aitken Basin, but it seems likely, since Von Kármán Crater, where *Chang'e 4* landed, is considered part of it and is at the same latitude.

Unlike Russian robotic sample returns, but like *Chang'e 5*, the *Chang'e 6* ascent stage will rendezvous with its orbital service module, transfer to the service module, which will apparently return to Earth and release the Returner (sample return module) while it passes by. If plans are like *Chang'e 5*, the service module will be repurposed for space exploration.

The entire mission (excluding extended mission by the Service Module) will take 53 days. Since I don't anticipate the lander doing exploration during the lunar night, that means no more than 14 days on the lunar surface so they must be taking a scenic route.

The Japanese Moon lander *SLIM*, which touched down on its nose in January, is proving amazingly resilient, waking up again in April after surviving its third lunar night. It is also producing science, mapping and remotely analyzing rocks and craters in its vicinity. They're naming the rocks after Japanese names of breeds of dog. One of the purposes of the mission is to determine differences and similarities in the formation of rocks on the Moon and on the Earth to determine the origin of the Moon. This has been an ongoing project since the Apollo era and is continuing with the Chang'e missions as well.

As one commenter remarked, it is now the real SLIM Shady.

On the verge of its Chang'e 6 sample return mission China has released the most detailed geological (selenological?) map of the Moon yet produced. This will be of enormous aid not only for future Chinese missions, but, since they released it internationally, for all future Moon missions.

We keep finding oceans beneath surfaces of the icy bodies of the outer solar system. Newest is Mimas, the Death Star lookalike that is the seventh largest satellite of Saturn. Odd details of its orbit indicate the presence of an ocean, but it was interesting that it is round and has mostly small craters except, of course for Herschel, which is 86 miles across on a moon that is 245 miles in diameter.

If the ocean is really there, it must have formed pretty far below the surface of Mimas since the surface has not been smoothed or cracked like Enceladus and Europa.

It looks like time is running out for the Mars Sample Return Mission due to increasing costs and a lengthening timeline. At the current rate of funding, it would take until 2040 to return the samples, and increased funding would cannibalize the funding of other missions, such as Dragonfly

and the NEO Surveyor. After receiving those estimates, NASA Administrator Bill Nelson said "I have asked our folks to reach out with a request for information to industry, to the Jet Propulsion Laboratory, and to all NASA centers," "and to report back this fall an alternate plan that would get [the samples] back quicker and cheaper."

As you might have heard, there was a total eclipse of the Sun on April 8 that passed across North America from the west coast of Mexico to Newfoundland, in particular crossing Texas and the far southeastern corner of Oklahoma. I'm recovering from a broken arm, so wasn't able to drive all the way to totality, so I drove as closely as I could and got more than 98% totality. I know Mike Hopkins and Steve Marino planned better and saw full totality. If you got to see totality, e-mail at my address listed toward the end of the newsletter.

The next total eclipse hits Spain, Iceland and the far northern regions of Siberia in August 2026. The August 2027 eclipse passes across Northern Africa, including Luxor, Egypt, where I bet the skies will be clear. Interestingly, the path of the March 20, 2034 total eclipse also passes across Luxor. These seem good bets though the mummies may rise for the occasion.

Although it is not total, there is an annular eclipse on October 2 which passes through Southern Chile and Argentina not that far from Tierra Del Fuego. The antumbra the region where the full ring is visible, last reaches Easter Island and the Falklands. I've seen posts urging people to send their used eclipse glasses to South America. The Moai Statues on Easter Island don't need them. I've seen ads for an eclipse cruise to Easter Island in astronomy magazines, but I just saw an annular eclipse from my home last fall.

Space-Related Articles

"Can We Catch an Interstellar Interloper," by David L. Chandler, *Astronomy*, June 24, pp. 12 – 21. Back in 2017, 'Oumuamua became the first interstellar visitor to the Solar System discovered (on its way out) from Earth. What are the chances that we could send a spacecraft to catch it? The problems are you need a huge velocity and, since it had some strange orbital anomalies, it might be hard to find. But this article has an ambitious way to do it.

But in 2029, ESA and JAXA are collaborating on the Comet Interceptor which will wait at the Earth-Sun L2 point waiting for another interstellar interloper or, failing that, a long-period comet. By then, the Vera Rubin Observatory may well have found dozens of interstellar visitors for the Interceptor to visit. In fact, it could do both: find a comet arriving from interstellar space. After all, we've already found one (2I Borisov in 2019).

Sky Viewing

The evening sky is losing its last planets this month, with Jupiter, Venus, Mercury and even Uranus having conjunctions with the Sun in the next five weeks, Saturn, Mars and Neptune are all up in the morning, but Neptune is still lost in the twilight six weeks after its own conjunction. It's worth noting that Jupiter, Venus, Mars and Saturn should all have been visible during the total eclipse last month.

We also are in a blank space with regard to meteor showers. Well, the daytime Arietids peak on June 7, and have a pretty good maximum rate but the "daytime" in their name gives a clue to the problem: peak visibility is not long before sunrise and the angle of the radiant is low in the sky.

The next decent shower is the Southern Delta Aquariids at the end of July, followed by the famous Perseids in mid-August.

Mercury is currently low in the sky before sunrise. At this time of year, the ecliptic is at a low angle at sunrise and high angle at sunset. Unfortunately, Mercury is currently a morning star, and, even though it is at greatest elongation on May 9, this is at such a low angle it will be difficult to see, being less than five degrees above the horizon a half hour before sunrise. Mercury goes through superior conjunction on June 14 and will be much easier to see around the beginning of July. Note that on June 4, Mercury and Jupiter will be separated by only seven minutes of arc, or a quarter the size of the Moon's disk. This will be very difficult to see since they are so low in the sky but may just be visible if the horizon is clear.

Venus has been a morning star for the last months (the Romans called her Lucifer) but is now too close to the Sun to see, having its conjunction with the Sun on June 4. This means that it will not be visible in June either but will return low in the western sky after sunset in early July.

Mars is low in the eastern sky before sunset, some 21 degrees to the lower left of Saturn. The two currently are equally bright but this may not be apparent since Mars has to shine through more atmosphere. It's currently still on the far side of the Sun, so isn't terribly bright, but is currently rising about 5:00 a.m. and will be rising about 3:30 a.m. by the beginning of June. Mars will get brighter through the rest of the year as it reaches opposition next January. It will be sixty million miles away then, so it's not a great opposition.

Jupiter is in conjunction with the Sun on May 18, and is currently lost within the sunset. It will appear soon before sunrise in early June and by the middle of June will be rising about an hour before the Sun. By June 30, it will rise around 3:30 a.m. (Also note the conjunction mentioned under "Mercury.")

Saturn is currently rising about 5:00 a.m. CDT and is about 15 degrees above the horizon an hour before sunrise. It still is around magnitude 1.0 (about the same as Mars). By the end of May, it will be twenty-six degrees above the horizon at that time and rising around 2:00 a.m. and more like fifty degrees by the end of June. It still has a while before it rises before midnight. Saturn's rings are currently tilted only three degrees to our line of sight, and sometime in 2025 this will become zero, making it a terrible time to try to find rings but a great time to see Saturn's moons. In fact, on June 14, Titan will traverse Saturn's disk around 4:00 a.m.. Rhea begins a transit about twenty minutes later but is much less conspicuous.

Uranus is in conjunction with the Sun on May 13, only five days before Jupiter, which means it will be futile to try to find it until mid-June, and late June would be a better bet. You will almost certainly need binoculars and a dark sky since it never gets above magnitude 5.7. To search for Uranus, try <https://lovethenightsky.com/see-uranus-through-a-telescope/>

Neptune is now nearly two months from conjunction and is still low in the sky before sunrise. You'd stand a pretty good chance of in late May with a small telescope. It's a difficult object to search for, but <https://lovethenightsky.com/see-neptune-through-a-telescope/> should be a help.

There was some fuss about Comet Olbers being in the sky during the total eclipse but really it's a pretty dim comet. Comet PanSTARRS was also in the sky but would have been even harder to see. Comet Olbers may be barely visible in dark skies.

The Lyrid meteor shower was also peaking around the time of the eclipse, but who looks for meteors during a total eclipse?

Viewing Opportunities for Satellites (May 11 – June 9, 2024)

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. 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 mission to the ISS is that of Starliner at 9:34 p.m. on May 6, i.e. just as this newsletter is being completed. Starliner has gone through delays, so keep your fingers crossed. There is a Progress cargo flight on May 30. There is a Dragon cargo flight in early June. There are no launches to *Tiangong* this month. China just launched a replacement crew on April 25. 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.

ISS 5/10 mag. -3.2				HST 5/15 mag. 1.7			
	Time	Position	Elevation		Time	Position	Elevation
9:08 p.m.	200°	10°		5:48 p.m.	244°	10°	
9:11	132	35		5:51	182	30	
9:14	65	10		5:55	120	10	
ISS 5/11 mag. -3.9				HST 5/16 mag. 1.7			
	Time	Position	Elevation		Time	Position	Elevation
5:15 a.m.	307°	10°		5:30 p.m.	237°	15°	
5:19	225	65		5:33	184	30	
5:22	143	10		5:36	122	10	
ISS 5/12 mag. -3.3				Tiangong 5/20 mag. -2.1			
	Time	Position	Elevation		Time	Position	Elevation
9:05 p.m.	200°	10°		5:42 a.m.	238°	11°	
9:09	318	66		5:45	153	74	
9:12	43	10		5:48	68	10	

Tiangong 5/22 mag. -2.0			
	Time	Position	Elevation
Appears from Earth's shadow.			
5:14:47 a.m.	258°	21°	
5:16:43	338	67	
5:20	62	10	

ISS 5/29 mag. -3.8			
	Time	Position	Elevation
9:34 p.m.	314°	10°	
9:37:35	42	81*	
9:39:49	129	19	

Vanishes into Earth's shadow.

*Passes close to Arcturus

HST 5/30mag. 1.6			
	Time	Position	Elevation
9:29 p.m.	243°	10°	
9:32	180	31	
9:35	125	15	

Tiangong 5/31 mag. -2.0			
	Time	Position	Elevation
5:28 a.m.	297°	10°	
5:31	23	74	
5:34	109	10	

HST 5/31 mag. 1.7			
	Time	Position	Elevation
9:10 p.m.	244°	10°	
9:13	182	30	
9:17	119	10	

Tiangong 6/2 mag. -2.3			
	Time	Position	Elevation
4:58 a.m.	290°	12°	
5:01	207	28	
5:04	124	10	

Tiangong 6/5 mag. -2.1			
	Time	Position	Elevation
9:30 p.m.	262°	10°	
9:33	151	51	
9:36	10	10	

Tiangong 6/6 mag. -1.4			
	Time	Position	Elevation
10:03 p.m.	262°	10°	
10:06	340	51	
10:09	58	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 9:33 p.m. on June 5, measure just under three fist-widths east of due south, then just over one 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>.

NASA has live coverage of the Boeing Starliner Crew Flight Test. This was on May 6 – 7, but if the launch is delayed a few days, it will still be covered from four or five hours before launch, through the docking later the next day, hatch opening two hours later.

Calendar of Events

Sometime in 2024: Maiden flight of the Aurora rocket. This will be the first orbital launch from Spaceport Nova Scotia. (Note: there is also an Aurora launch in July as part of a rideshare. That one is being launched by a Falcon 9 from Vandenberg AFB in California.)

Sometime in 2024: *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.

Mid-2024: Launch of *Polaris Dawn* flight carrying Jared Isaacman and four other civilians into space. https://en.wikipedia.org/wiki/Polaris_Dawn

May 7 - 10.: First crewed test launch of *Boeing Starliner-1* to the ISS. For more information, see https://en.wikipedia.org/wiki/Boeing_Starliner.

May 9: Mercury is at greatest western elongation, 26.4° from the Sun (hence can be seen before sunrise).

May 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. The speaker is Dr. Steve Levin on the *Juno* space probe to Jupiter.

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

May 13: Uranus is in conjunction with the Sun.

May 18: Jupiter is in conjunction with the Sun.

May 23 – 26: International Space Development Conference 2024 in Los Angeles, California. For more information, visit <https://isdc.nss.org/>.

June (moved from April): First ISS Cargo Resupply mission for *Dream Chaser*.

June: Maiden flight of the Tianlong reusable launch vehicle.

June 4: Venus is in superior conjunction with the Sun.

June 8: Oklahoma Space Alliance meeting, 2:00 p.m., Norman Computers. Meeting information will be posted at <http://osa.nss.org>.

June 14: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See www.okcastroclub.com for details.

June 14: Mercury is in superior conjunction with the Sun.

June 24: Launch of SVOM, a Chinese X-ray telescope.

Late June: Maiden flight of Ariane 6. More precisely, Ariane 62.

Third quarter of 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.

Early July: Transporter 11 flight by Falcon 9, carrying a slew of small satellites, many technology demonstrations, by many countries. In addition to the usual suspects, this has satellites from Argentina, Croatia, Finland, Poland, Spain, and the United Arab Emirates

July 12: 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 13: Oklahoma Space Alliance meeting, 2:00 p.m., Norman Computers. Meeting information will be posted at <http://osa.nss.org>.

July [moved from June] : First (uncrewed) *Gaganyaan* flight test. For more information, see https://en.wikipedia.org/wiki/Gaganyaan_1

July 22: Mercury is at its greatest eastern elongation, 26.9° from the Sun (hence can be seen before sunset).

July 23: Pluto is at opposition.

July 27: Peak of Delta Aquariid meteor shower.

August 10: Oklahoma Space Alliance meeting, 2:00 p.m., Norman Computers. Meeting information will be posted at <http://osa.nss.org>.

August 12: Peak of the Perseid meteor shower.

Mid-August: Ninth *Crew Dragon* mission to the ISS.

August 18: Mercury is at inferior conjunction with the Sun.

September 1: 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.

September 4: Mercury is at greatest western elongation, 18.1° from the Sun (hence can be seen before sunrise).

September 7: Saturn is at opposition.

September 11: Launch of Expedition 71/72 to the ISS by Soyuz.

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

September 20: Neptune is at opposition.

September 29 [Moved from August.]: *ESCAPADE Blue* and *Gold Mars* Orbiters launch by New Glenn. This is the maiden flight for Blue Origin's New Glenn rocket. For more information, see en.wikipedia.org/wiki/EscaPADE.

September 30: Mercury is in superior conjunction with the Sun.

Fourth quarter of 2024: 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>

Fourth quarter of 2024: Maiden flight of Perigee Aerospace *Blue Whale 1* reusable launch vehicle from Jeju Space Center in South Korea.

Fourth quarter of 2024: 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>.

Fourth 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.

Fourth quarter of 2024: *Hakuto R* Mission 2 carrying iSpace's Resilience lunar lander and a Luxembourg (!) iSpace Europe lunar mini-rover. [*Hakuto R* mission 1 was the one that crash landed with a UAE rover aboard.]

October 2: Annular eclipse of the Sun. This one is almost entirely over the South Pacific Ocean, touching land in Easter Island and southern tips of mainland Chile and Argentina. It will be partial in Hawaii, southern South America, and a bunch of small South Pacific islands as well as Western Antarctica.

October 8: 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. For more information, visit [https://en.wikipedia.org/wiki/Hera_\(space_mission\)](https://en.wikipedia.org/wiki/Hera_(space_mission)).

October 10: Launch of *Europa Clipper* orbiter to Jupiter's moon Europa. For more information, https://en.wikipedia.org/wiki/Europa_Clipper,

October 21: Peak of the Orionid meteor shower.

Late October: 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.

November: Maiden flight of *Pallas-1* launch vehicle by Galactic Energy in China. For information, see en.wikipedia.org/wiki/Pallas-1.

November: 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. For information, see [en.wikipedia.org/wiki/VIPER_\(rover\)](https://en.wikipedia.org/wiki/VIPER_(rover))

November 16: Uranus is at opposition.

November 16: Mercury is at greatest eastern elongation, 22.5° from the Sun (hence can be seen after sunset) .

December 5: Mercury is at inferior conjunction with the Sun.

December 7: Jupiter is at opposition.

December 13: Peak of Geminid meteor shower.

December 22: Peak of Ursid meteor shower.

December 24: Mercury is at greatest western elongation, 22.0° from the Sun (hence can be seen before sunrise).

December 24: *Parker Solar Probe* makes its first pass through the outer corona of the Sun. For more information, see <http://parkersolarprobe.jhuapl.edu>.

December 30: 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

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

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.

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: 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 2025: China will launch an Asteroid Impactor and Orbiter and flyby to asteroid 2019 VL5. For more information, see <https://spacenews.com/china-to-target-asteroid-2019-vl5-for-2025-planetary-defense-test/>.

Sometime in 2025: Uncrewed Starship lunar landing demonstration.

Sometime in 2025 [maybe]: India launches its first crewed orbital flight *Gaganyaan*. For more information, en.wikipedia.org/wiki/Gaganyaan.

First Quarter of 2025: India launches its third uncrewed orbital flight *Gaganyaan-3*. For more information, en.wikipedia.org/wiki/Gaganyaan. [Note: this was previously supposed to be crewed.]

First quarter of 2025 (moved from 2024): A SpaceX Nova-C mission to the Moon takes Intuitive Machines' IM-3 lander, NASA's Lunar Vertex rover, and several NASA Cadre rovers.

First quarter of 2025: First crewed mission of *Starliner 1* to the ISS. For more information, visit https://en.wikipedia.org/wiki/Boeing_Starliner-1.

First quarter of 2025: 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 16, 2025: Mars is at opposition, 60 million miles from Earth. In other words, this is a poor opposition.

February 2025: Launch of *IMAP* heliophysics probe and *Solar Cruiser* to the Earth-Sun L1 Lagrangian point (the one between us and the Sun).

April 20, 2025: *Lucy* flies by asteroid 52246 Donaldjohanson.

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>.

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>.

August 2025: launch of Vast's *Haven-1* space station. For more information, <https://en.wikipedia.org/wiki/Haven-1>.

Third quarter of 2025: First flight test of ESA's uncrewed Space Place *Vega-C*.

September 2025: *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.

November 2025: 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.

December 2025: *BepiColombo* arrives at Mercury orbit.

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

Sometime in 2026: Launch and landing of Japan/India *LUPEX* (Lunar Polar Exploration) lander. For more information, see https://en.wikipedia.org/wiki/Lunar_Polar_Exploration_Mission.

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

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.

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

Mid-2026: Uncrewed *Starship* mission to Lunar South Pole, carrying Astrolab's FLEX lunar rover.

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

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

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.

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.

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.

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.

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.

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

Possibly in 2028 (moved from December 2024): Launch of India's *Shukrayaan-1* Venus orbiter. For more information, see <https://en.wikipedia.org/wiki/Shukrayaan-1>.

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

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 half of 2028: 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.

March 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.

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.

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

Sometime in 2029: *DESTINY+* flies by asteroid 3200 Phaethon, the parent body of the Geminid meteor shower.

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.

Sometime in 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)).

April 21, 2029: *OSIRIS-APEX* rendezvous with the asteroid Apophis. Note: *OSIRIS-APEX* is the same spacecraft as *OSIRIS-REx*; it is re-named “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>

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 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.

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 [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: Launch of ESA’s *EnVision* Venus orbiter.

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

July 2031: Hayabusa 2 arrives at asteroid 1998 KY26.

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

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

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.

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.

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

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