OKLAHOMA SPACE ALLIANCE

OUTREACH – January 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 January 13, details inside

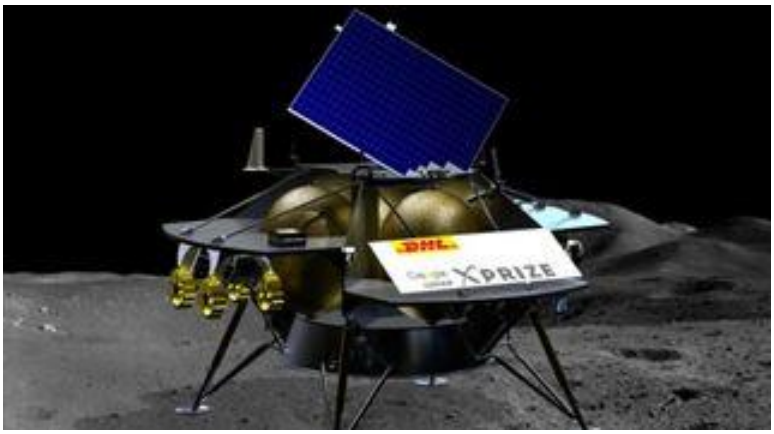

Figure 1 Astrobiotic Illustration of *Peregrine* lander on the Moon. It will land on February 25 (hopefully softly)

OKLAHOMA SPACE ALLIANCE OUTREACH
January 2024

January Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, January 13, 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.

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

Saturday January 13, 2:00 p.m. (tentative)

1. Introductions and review of Space events this past month
2. What's Happening in Space, News, Pictures, and Videos approximately one hour. See http://osa.nss.org before the meeting for items to be discussed.
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
    a. Review OSA treasurer's report
    b. Minutes of November meeting
    c. Annual Report
    d. Posters
5. Video (to be announced)
6. Chat

Notes on Oklahoma Space Alliance Christmas Party

Oklahoma Space Alliance had its annual Christmas Party at Claire and Clifford McMurray's house. In attendance were our hosts, Mark Deaver, Adam Hemphill, Syd Henderson, John Northcutt, Dave Saint John, Tim Scott, Dave Sheeley, Edwin Strickland, and John Strickland. This was the election at which we elected our officers for 2024. Adam Hemphill was elected President, Clifford McMurray Vice-President, Syd Henderson Secretary and Tim Scott Treasurer. John and Ed brought articles and books to look at during the meeting, and we signed petitions for people running for the board of the National Space Society. After dinner, which consisted of dishes brought as a potluck, we discussed space a bit more, then went into a discussion of politics and world affairs.

Minutes of November 11 Oklahoma Space Alliance

Oklahoma Space Alliance met November 11, 2023, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending in person were Clifford and Claire McMurray, Mark Deaver, Adam Hemphill, Chris Murdock, Dave Sheely, Tim Scott, 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/Update2311.pdf** so I'll cover the details that aren't covered there.

The Oklahoma Space Alliance Christmas Party and election are at the McMurray house on December 9.

When the *Lucy* probe arrived at Dinkinesh, it discovered it had a satellite. It turns out that this satellite is itself a contact binary. This is the first contact binary known to orbit an asteroid.

Israel is working on an Arrow 4 interceptor missile. First intercept was of a missile fired from a thousand miles away in Yemen.

With the death of Frank Borman, Jim Lovell is now the oldest living astronaut. They were crewmates on *Apollo 8*.

We watched the test launch of India's *Gaganyaan 2* spacecraft. This was to test the escape system, which will be essential since *Gaganyaan 3* will carry India's first astronauts.]

Virgin Galactic is going to go to one launch per quarter. The rest of Unity's flights will be research flights, although there will still be paying passengers. Also, there will no longer be an astronaut instructor on every flight. They are working on a new craft for 2026.

Blue Origin lands by parachute while Virgin Galactic uses the feathering technique to land on a runway. It's a challenge for the FAA to come up with a plan that covers both.

The US Fish and Wildlife Service will have to review Starship launches.

Stoke Space's second stage uses aerospike technology. This is the one we reviewed a while back that uses the dynamically cooled heat shield.

The Chinese space company, Space Pioneer, expects to fly thirty flights a year in a couple of years.

We have $831.42 in the checking account and $267 in cash for a total of $1098.42.

Chandra has found the most distant X-rays from a black hole.

Officer nominations for 2024 are :Adam Hemphill for President, Clifford McMurray for Vice-President, Syd Henderson for Secretary and Tim Scott.

Minutes by OSA Secretary Syd Henderson

Space News

At 1:18 a.m. (Central Time) a Vulcan Centaur rocket lifted off from Cape Canaveral. Five minutes later the Centaur upper stage separated and a few minutes later a burn sent it on a trajectory to the Moon. At 2:08, Astrobotics *Peregrine* moon lander separated on a trajectory which will take it on a looping trajectory around the Moon which will eventually allow it to make a (hopefully) soft landing on the Moon on February 23 in the Sinus Viscositatus (Bay of Stickiness—hey, I didn't name it—or maybe Viscous Bay). This feature wasn't named until 2023 so it won't appear on most Lunar maps but it's at 37 degrees north and 40 degrees west, which puts it at the south end of a highland between Mare Imbrium and the north part of Oceanus Procellarum.

This mission marks several firsts, including the first launch of the United Launch Alliance's Vulcan Centaur and, if successful, the first spacecraft built by a private company to make a soft landing on the Moon. (I specify soft since iSpace's *Hakuto-R* made an unintentional hard landing.) Or maybe not, since NOVA-C is taking a quicker trajectory and may beat *Peregrine* by a day. Since NOVA-C is not launching until mid-February at the earliest, I expect *Peregrine* will get there first if successful.

However, Peregrine suffered a 'critical' fuel loss on the first day of the journey that has put the landing in jeopardy. I'm going to proceed in hope the problem is fixed but it's likely much of this is moot and *Peregrine* will have to do any science from lunar orbit.

The *Peregrine* mission is a truly international effort of which the lander is only part, and many of the countries contributing are not only sending their first projects to the Moon, but in some cases their first to space. *Peregrine* carries no fewer than six mini-rovers, five of them as part of Mexico's Colmena*5 project and the other Carnegie Mellon's University's *Iris* rover. The Colmena rovers have a mass less than 60 grams (equivalent of half an ounce in Earth gravity) and are 12 centimeters (4.7 inches) in diameter, but they have wheels and are designed to investigate moondust. *Iris* has a mass of two

kilograms. This has a camera for taking images, but the main purpose is to adapt the Cubesat approach to lunar mini-rovers.

Other countries making their lunar debut at the UK (image bank), the Seychelles (a bitcoin project), Hungary (a time capsule), Germany (a radiation detector), Argentine (photos), and Canada (literary archive), most of which will be preserved for the future in orbit if need be.

What has really gotten a lot of attention in the days leading up to launch is the famous people whose remains are being carried on *Peregrine*. This includes Gener and Majel (Barrett) Roddenberry, Nichelle Nichols, James Doohan and DeForest Kelley from *Star Trek*, astronaut Philip Chapman and DNA from George Washington, John F. Kennedy and Dwight D. Eisenhower. I understand George H. W. Bush also has DNA aboard but can't confirm it.

The human remains are part of two "human mausoleum" projects, one by Elysium Space and the other Celestis. Altogether there are ashes or DNA from 270 people. There were some last-minute objections from the president of the Navajo nation. The remains are not designed to be spread on the Moon but to stay contained on the lander (but, of course, if the lander crashes, they will be spread). I suspect there already is human DNA on the Moon from the Apollo missions.

Peregrine is actually part of the Artemis program so contains a bunch of NASA instruments in addition to the international contributions.

I should say something about the NOVA-C mission. This mission is one of a series by another private company, Intuitive Machines, as part of the commercial portion of the Artemis program. The three NOVA-C missions going up this year will all be launched by SpaceX's Falcon 9. This will land near the lunar south pole at the crater Malapert A, which is one of at least six small craters around the larger Malapert, which is 42 miles in diameter. The smaller craters range from six to twenty-four miles in diameter, with Malapert A being about fifteen miles in diameter. Malapert Crater itself was the location of the moon base in the rather notorious SF series *Space: 1999.* All these craters are impact craters but as near as I can tell, they were not formed at the same time.

NOVA-C doesn't have a rover on the mission, but does carry the International Lunar Observatory, which is a private scientific mission by the International Lunar Observatory Association of Kamuela, Hawaii. The ambition is to show the practicality of an observatory on the surface of the Moon. It will function during the lunar day (which I assume means it is protected from sunlight--and earthlight--reflection off the lunar surface). I don't know if it can function through lunar night, which would require an internal heat source, but probably not.

NOVA-C carries its own time capsule, Lunaprise, which is described as an art museum on the Moon. This contains miniaturized copies of artwork on etched nickel nanofiche disks from selected artists around the world. As near as I can tell, just the artwork, not the DNA of the artists. The disks will have to be read by a microscope. There are also music and movie scripts.

Space Related Articles

"China's Deep-Space Ambitions," by Andrew Jones, *Astronomy*, February 2024, pp. 22 – 27. China is not only sending missions to the Moon and Mars but is also planning missions much farther out. In addition to its own Mars sample return mission (*Tianwen 3*), this includes *Tianwen 2*, which will retrieve material from asteroid Kamo'oalewa (why do I assume that name is Hawaiian) and rendezvous with a comet. *Tianwen 4* is more ambitious, sending an orbiter to Jupiter and a small probe to fly by Uranus. The latter won't happen until after 2040, but only one spacecraft has ever visited Uranus, namely *Voyager 2* in 1986.

It's possible that Uranus probe may leave the Solar System, becoming the seventh spacecraft to do so. Why seventh? Because China is also planning to send two probes to explore the heliosphere, one in the forward direction and one to the tail. Of course, the *Voyagers* have already reached the heliopause, but the Chinese missions would be dedicated spacecraft, while the *Voyager*s were primarily planetary missions.

Incidentally, Kamo'oalewa is a quasi-satellite of the Earth: that is, an asteroid which has an orbital period almost exactly that of Earth so that appears to accompany us. Speculation is that it may in fact be a piece of the Moon that was ejected. (See https://www.astronomy.com/science/evidence-builds-kamooalewa-is-a-chunk-of-the-moon-following-earth/) It can approach within three million miles of Earth or recede to more than 23 million miles.

"Space Dust: A Retrospective," by Jerry Oltion, *The Magazine of Fantasy & Science Fiction*, November-December 2023, pp 208-213.

A little nostalgia here: from November 1958 through February 1992, Isaac Asimov had a monthly science (usually) essay in *The Magazine of Fantasy & Science Fiction* which I followed avidly in collections and eventually the magazine itself. There were 399 monthly essays, and a 400th finished later by his wife. The very first of these was "Dust of Ages" about micrometeorites arriving on the Earth and on the Moon. Shortly before, *Explorer 1* detected many more impacts than were expected, which led Hans Pettersson to climb mountains in Hawaii to measure the dust at high altitude and try to figure out just how much dust came from space. He calculated 14,300,000 tons at any given time. This would eventually settle on the Earth and be subject to geological processes so the whole Earth isn't covered in feet of dust.

But what about the Moon? Asimov took this figure and speculated that the Moon could be 50 feet deep in dust, especially in low spots. Thus, a lander or an astronaut on say, the Sea of Tranquility would not only sink over his head in dust, but the whole lander would sink. This, you'll notice, didn't happen on *Apollo 11*. As it turns out, Hans Pettersson's assumptions were invalid by a factor of 500. But before we realized this, Arthur C. Clarke wrote *A Fall of Moondust* in which a spacecraft does sink into a pile of dust. This was in 1961. There was also a story in the November 1958 issue of *F&SF* in which the same thing happens, and it appeared in the same issue as the Asimov essay.

Anyway, Oltion's article is about what we now know about dust in the inner solar system. There is a phenomenon called the Zodiacal Light which appears in the sky on very dark skies that is produced by the scattering of sunlight by this dust; as its name implies, it appears in the Zodiac. Related to this is *gegenschein* or counterglow, which is directly opposite the sun and is the reflection of sunlight off the dust.

Interestingly, the dust in the inner solar system extends out to a bit over two astronomical units of the Sun. This is because particles at that distance would be in a four-to-one orbital resonance with Jupiter and the giant planet keeps it confined.

[Similar resonances clear out certain orbits in the asteroid belt; these are known as the Kirkwood gaps, with the two-to-one resonance being particularly pronounced. Farther out in the Solar System, resonances with Saturn's moons create gaps in Saturn's rings.]

I speculate that beyond the 4-1 resonance orbit with Jupiter the dust resumes until you reach the next resonance although that may be in the asteroid belt.

Sky Viewing

After last week's Quadrantid meteor shower, we're out of major meteor showers or celestial events until April, when we simultaneously have a total solar eclipse visible in Oklahoma and the Lyrid meteor shower. Well, there is a conjunction of Venus and Mars but that will be difficult to see.

Mercury is half-lit and moving away from us, which oddly means it's getting brighter (since showing more of its face makes it brighter, unlike Venus which is brightest as a fat crescent). However, it is still fairly low in the east before sunset. Mercury, Venus and Mars are close together in the eastern sky in late January and early February, but all are pretty low and on the far side of the Sun and Venus is the only one that's easy to see, and only if you have a clear horizon. Mercury will be impossible to see in late February since it is in superior conjunction with the Sun on February 25.

That said, **Venus** is still magnitude -4.0. It's still rising about three hours before the Sun. It's fairly low in the morning in Libra and passes through Scorpius on its way to Sagittarius in early February. This means that it will be as far south as it can get. On February 7 it will be seven degrees east of the Moon which itself is as far south as it can get since it is five degrees south of the southernmost part of the ecliptic. This means neither is high in the sky as seen from Oklahoma.

This is still better than the conjunction of Venus and Mars on February 22. They will be separated by 40 arcminutes (the apparent diameter of the Moon is 30-arcminutes) but they are rising only an hour before the Sun, and though Venus will be magnitude -3.9 and should be visible, Mars will be magnitude 1.3 and hard to see. Despite its low elevation in late February, Venus is not in conjunction with the Sun until June.

Mars is finally starting to appear in the morning sky but is going to be low in the morning sky for some time. It is returning from the far side of the Sun and will be magnitude 1.3 which means it will be very hard to see at low elevation. By comparison, Mercury gets up to magnitude -1.0 but you still have to have it near peak elevation and have a clear horizon to see it. (I never have.) So, you may have to wait several months to see Mars again.

Jupiter is by far the most prominent of the planets in January and February. Shining magnitude -2.5 in the constellation Aries (now you know where Aries is) it is high in the south at sunset and doesn't set until after midnight. Even in late February it will set around 10:30 p.m. (still in Aries) by then it will be magnitude -2.2.

Saturn is still up in the southwest after sunset but is down to magnitude 1.0 and setting around 8:00 p.m. It is in the constellation Aquarius and is the brightest "star" in that part of the sky. In February we say goodbye to Saturn for a while as it not only grows dimmer but fades into twilight. It will not be visible after the first week of February and reaches conjunction with the Sun on February 28.

Uranus is in Aries with Jupiter but at the other end, so it is fourteen degrees to the east of Jupiter. This does mean it's in the sky all evening, but it is only magnitude 5.6—bright for Uranus—and requires binoculars or a small telescope. To search for Uranus, try https://lovethenightsky.com/see-uranus-through-a-telescope/

Neptune is still hanging around the border between Pisces and Aquarius about twenty degrees east of Saturn. This means that it's high in the evening sky at sunset, but in an inconspicuous part of the sky and requires a small telescope. Things get worse in late February as Neptune approaches its March 17 conjunction with the Sun. To search for Neptune, try https://lovethenightsky.com/see-neptune-through-a-telescope/.

Viewing Opportunities for Satellites (January 12 – February 15, 2024)

I'm extending this a few days to get the excellent viewing opportunity for *Tiangong* on February 15.

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 Axiom 3 mission's going to the ISS on January 17, and a Cygnus cargo flight on January 29 There is a cargo launch to Tiangong on January 15. 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. The Hubble Space Telescope passes usually repeat five or six times with similar trajectories and 15 minutes or so earlier each day, to about 30 degrees above the horizon. I quit on January 14 (evening) because it will be in twilight and February 9 (morning) since it spends too much time in shadow.

Hubble 1/12/24 mag. 2.1

Time	Position	Elevation
6:59 p.m.	237°	10°
7:02:02	175	29
7:03:50	132	21

Vanishes into Earth's Shadow

Tiangong 1/13/24 mag. -1.1

Time	Position	Elevation
6:15 p.m.	276°	10°
6:17	345	36
6:20	53	11

Hubble 1/13/24 mag. 2.1

Time	Position	Elevation
6:42 p.m.	239°	10°
6:45	177	30
6:48	120	14

Hubble 1/14/24 mag. 2.2

Time	Position	Elevation
6:25 p.m.	241°	10°
6:28	179	31
6:32	116	10

Hubble 1/15/24 mag. 2.2

Time	Position	Elevation
6:08 p.m.	276°	10°
6:11:30	180	31
6:15	118	10

ISS 1/15/24 mag. -3.8

Time	Position	Elevation
6:41 p.m.	229°	10°
6:44:22	317	84
6:46:24	45	22

Vanishes into Earth's Shadow

Tiangong 1/19/24 mag. -1.7

Time	Position	Elevation
6:35 p.m.	303°	10°
6:37:48	18	45
6:39:47	86	19

Vanishes into Earth's Shadow

Tiangong 1/20/24 mag. -1.8

Time	Position	Elevation
7:10 p.m.	289°	10°
7:13:08	209	60*
7:39:59	148	40

Vanishes into Earth's Shadow

*Passes just below Jupiter

Tiangong 1/21/24 mag. -2.2

Time	Position	Elevation
6:08 p.m.	298°	10°
6:12	22	72
6:15	108	10

ISS 2/1/24 mag. -3.9

Time	Position	Elevation
7:23 p.m.	312°	10°
7:26:45	236	90
7:27:24	133	55

Vanishes into Earth's Shadow

ISS 2/2/24 mag. -3.4

Time	Position	Elevation
6:34 p.m.	324°	10°
6:38	39	46
6:41	114	10

ISS 2/4/24 mag. -3.8

Time	Position	Elevation
6:32 p.m.	303°	10°
6:36	226	52
6:39	148	10

Tiangong 2/4/24 mag. -2.2

Time	Position	Elevation
6:57 a.m.	243°	10°
7:00	155	87*
7:03	66	10

*Passes just above Arcturus

Tiangong 2/6/24 mag. -2.0

Time	Position	Elevation
Appears from Earth's Shadow		
6:30:13 a.m.	264°	19°
6:32:24	339	57
6:35	60	10

Hubble 2/6/24 mag. 2.2

Time	Position	Elevation
6:54 a.m.	241°	10°
6:58	179	31
7:01	116	10*

*Passes just above Venus on these morning passes, but see below

Hubble 2/7/24 mag. 2.1

Time	Position	Elevation
6:37 a.m.	243°	10°
6:41	180	31
6:44	107	10

Hubble 2/8/24 mag. 2.0

Time	Position	Elevation
6:20 a.m.	239°	14°
6:23	182	31
6:27	119	10

Hubble 2/9/24 mag. 2.0

Time	Position	Elevation
Appears from Earth's Shadow		
6:04:37 a.m.	227°	21°
6:06:24	184	31
6:10	111	10

Tiangong 2/15/24 mag. -2.2

Time	Position	Elevation
6:49 a.m.	294°	10°
6:52	205	84
6:56	118	10*

*Passes just north of Venus

Although the Hubble Space Telescope passes just above Venus at the close of its passes in early February, it is also very low in the sky and probably can't be seen (though Venus should be visible with a clear horizon.)

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 7:13 p.m. on January 20, measure three fist-widths west of due south, then six fist-widths above the horizon. (Note that on February 1 at 7:27 p.m., the ISS is straight overhead, and there are several ISS and Tiangong passes that are for all practical purposes. The HST doesn't become easily visible until it's twenty degrees up, but the ISS and Tiangong should be visible through all their passes.

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.

I have no listing of major live events (the schedule only shows through January 17) but some which should be covered live are the arrival and departure of Axiom-3 around January 18, the Cygnus launch and arrival on January 29, and the Crew Dragon launch to the ISS and Nova-C launch to the Moon in mid-February.

Calendar of Events

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

January 12: Mercury is at greatest western elongation, 23.5° west of the Sun (hence can be seen before sunrise.

January 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.

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

January 15: Cargo launch to the Tiangong space station.

January 17: 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.

January 29: Cygnus Spacecraft launched by Falcon 9 to ISS. On the way SpaceX will drop LizzieSat-2 and a couple of communications into orbit.

February 9: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See www.okcastroclub.com for details.

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

Mid-February: [moved from January]: 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

Mid-February: Eighth *Crew Dragon* mission to the ISS.

February 25: Mercury is in superior conjunction with the Sun.

February 28: Saturn is in conjunction with the Sun.

March [Moved from 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.

March: Space X launch of a multitude of small spacecraft, including the first from Senegal. There are also small satellites from Australia, Croatia, Djibouti, and Poland.

March 1: 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.

March 4: SpaceX cargo flight to the ISS. ELaNa, consisting of seven CubeSats will also launch on this flight,

March 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.

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

March 17: Neptune is in conjunction with the Sun.

March 18: Launch of China's Queqiao-2, the relay satellite for the *Chang'e-6* mission to the far side of the Moon.

March 21: Launch of Expedition 70/71 by Soyuz to the ISS.

March 24: Mercury is at its greatest eastern elongation, 18.7 ° east of the Sun (hence can be seen after sunset).

Second 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.

Second 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.

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

April: First ISS Cargo Resupply mission for Dream Chaser.

April 1: Mercury is at inferior conjunction.

April 6: 3:20 a.m.: conjunction of the Moon and Saturn. This will be an occultation from some locations.]

April 8: 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.

April 8: Peak of Lyrid meteor shower. Note that this is happening at the same time as the eclipse.

April 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.

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

April 14: First crewed test launch of *Boeing Starliner-1* to the ISS. For more information, see https://en.wikipedia.org/wiki/Boeing_Starliner.

May: 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 3: Peak of Eta Aquariid meteor shower.

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

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.

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: Mercury is in superior conjunction with the Sun.

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

Second half 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.

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.

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 6 – 15: *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.

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 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 Espedition 71/72 to the ISS by Soyuz.

September 20: Neptune is at opposition.

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.

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

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.

October: 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).

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 21: Peak of the Orionid meteor shower.

November *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: 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)

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

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.

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: Israel launches its *Beresheet 2* lander 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 flyby to asteroid 2019 VL5. For more information, see https://spacenews.com/china-to-target-asteroid-2019-vl5-for-2025-planetary-defense-test/.

First quarter of 2025: First crewed mission of Starliner 1 to the ISS.

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.

February 2025: Launch of IMAP heliophysics probe and Solar Cruiser to the Earth-Sun L1 Langrangian 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.

November 2025: 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.

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 [Moved from 2025]: 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 [Moved from 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).

Sometime in 2026 [Moved from January 2025]: OSAM-1 will rendezvous with Landsat 7 and refuel it. For more information, see https://en.wikipedia.org/wiki/OSAM-1

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.

May 2006: The *Psyche* probe flies by Mars.

July 2026: *Hayabusa 2* flies by asteroid 2001 CC_{21}.

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] 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.

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 Tronan asteroid 15094 Polymele.

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. 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.

Sometime in 2028 [Moved from 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).

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 (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.

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 [Moved from June 2027]: Launch of *Dragonfly*, the Titan helicopter mission. For information, see 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 2028: Launch of China's *Tianwen-3* Mars sample return mission.

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.

Sometime in 2029: Launch of *VERITAS* orbiter and Venus Atmosphere Sample Return Mission to Venus.

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

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

September 2029: Launch of Artemis 5 to the Moon.

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

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.

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.

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.

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.

Oklahoma Space Alliance Officers, 2024

Adam Hemphill, President
Clifford McMurray, Vice-President
405-329-4326 (H) 405-863-6173 (C)
Syd Henderson, Secretary & *Outreach* Editor,
405-321-4027 (H) 405-365-8983 (C)
Tim Scott, Treasurer, 405-740-7549 (H)

OSA E-mail Addresses and Web Site:

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

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

Other Information

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

Science Museum Oklahoma (former Omniplex) website is www.sciencemuseumok.org. Main number is 602-6664.

Tulsa Air and Space Museum, 7130 E. Apache, Tulsa, OK 74115.
Web Site is www.tulsaairandspacemuseum.com. Phone (918) 834-9900.

The Mars Society address is The Mars Society, 11111 West 8th Avenue, Unit A, Lakewood, CO 80215. Phone: (303) 980-0890Their 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]

OKLAHOMA SPACE ALLIANCE
A Chapter of the National Space Society
MEMBERSHIP ORDER FORM

Please enroll me as a member of Oklahoma Space Alliance. Enclosed is:
_____ $10.00 for Membership. (This allows full voting privileges but covers only your own newsletter expense.)
_____ $15.00 for family membership
_____ TOTAL amount enclosed.

National Space Society has a special $20 introductory rate for new members. Regular membership rates are $52, Student memberships are $36, Senior $42. Part of the cost is for the magazine, *Ad Astra*. If you choose to receive the magazine digitally, memberships are $40 for regular, $24 for students and $30 for seniors. Mail to: National Space Society/ Mail Code NSS/State Road 405/Building M63-306/Kennedy Space Center 32899 **(new address)** or join at **www.nss.org/membership.** (Brochures are at the bottom with the special rate.) Be sure to ask them to credit your membership to Oklahoma Space Alliance.

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.

Do you want to be on the Political Action Network?
_____ Yes_____ No. [See brochure for information.]

Name_____

Address_____

City_____ State___ ZIP_____

Phone (optional or if on phone tree)_____

E-mail address (optional)_____

OSA Memberships are for 1 year, and include a subscription to our monthly newsletters, *Outreach* and *Update*. Send check & form to **Oklahoma Space Alliance, 102 W. Linn, #1, Norman, OK 73071.**