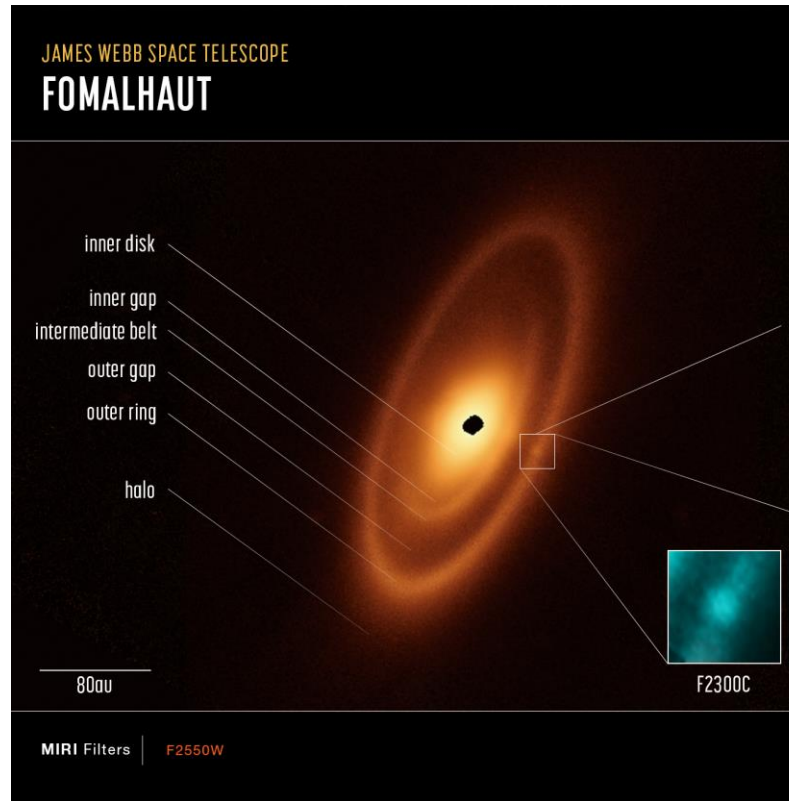


# OKLAHOMA SPACE ALLIANCE

## OUTREACH – May 2023

**102 W. Linn #1, Norman, OK 73069**

Oklahoma Space Alliance will meet at either the  
at the room next to Norman Computer  
at 2:00 p.m. on May 13, details inside



**Fomalhaut (Alpha Piscis Austrini) showing the asteroid belt  
(Webb Image from NASA)  
See “Space News.**

## OKLAHOMA SPACE ALLIANCE OUTREACH May 2023

### May Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, May 13, at the location next to Norman Computers on West Main. Prospective members are welcome.

The meeting room is at the Cyber Hall and Gaming Lounge at Norman Computers. Norman Computers is at 916 W Main St, opposite Norman High School. The phone number is (405) 292-9501. To get to the meeting space from points north, take the Highway 77 exit off I-35, and continue south until you reach Main Street. Norman Computers is about a block and a half west of this on the south (left) side in a small mall.

We will have this meeting on Zoom for those who cannot attend in person: To join the meeting, go to <https://ti-nyurl.com/y2qtab28>. If the link doesn't work, call Clifford McMurray, President 405-329-4326 (H), 405-863-6173 (C) (e-mail [cliffmcmurray@hotmail.com](mailto:cliffmcmurray@hotmail.com)) or Syd Henderson at 405-365-8983 (C) (e-mail [sydh@ou.edu](mailto:sydh@ou.edu)) and we will send you updated information.

### Saturday May 13, 2023, 2:00 p.m. (tentative)

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

### Minutes of April 8 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met April 8, 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, Steve Marino, Tim Scott, Dave Sheely, and Syd Henderson. Robin Scott attended by phone. 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/Update2304.pdf> so I'll cover the details that aren't covered there.

*Artemis 2* will launch no earlier than November 2024. We watched the video of the introduction of the Artemis Crew. [I have the dates for Artemis 3 through 8 in the calendar of events, but these should be taken with an ounce of salt given previous delays and the problems with *Starship's* flight test (which will mean a lot of work fixing and revamping the launch pad.)

Adam: The Orion spacecraft has an ISS level of recycling.

Virgin Orbit didn't get its money from Matthew Brown, so it is having to lay off a good percentage of its workforce.

We watched a video of the Terran 1 launch of its 3D printed rocket. The first stage was completely successful but the second failed to light,

Soyuz MS-22, the one with the coolant leak that meant several astronauts had an unexpected extension of their missions, did bring back the cargo even if it couldn't bring back the cosmonauts. We watched the landing. The part with the leak was allowed to burn up.

We watched a video presenting the Axion space suits.

NASA has a contract with a company called LunaNet to provide communication, networking, navigation, and science services to and on our Moon base.

A Gamma Ray burst gave off more energy than the Sun will emit in its lifetime.

We examined an article of Lunar Outpost's MAPP lunar rover and a video on it. This company has partnered with another firm (LunaCrush) to encrypt a fortune in Bitcoin to be unlocked by whoever reaches the rover first.

Tianlong's fuel is derived from coal. Tianlong-3 is next year. It is capable of launching 50 satellites at once for China's new constellation.

We examined an article on the eruption of Maat Mons, an active volcano on Venus. We watched a video on the difference between Venus and Earth's history. Earth's magnetic field protects it against geomagnetic storms (which can otherwise decompose water vapor, letting hydrogen escape. (I suspect one reason Venus doesn't have a magnetic field is that it rotates once every 224 days, which may be too slow to create one.)

We have our first detailed map of water near the Moon's South Pole.

There was no change in our checking account. Syd got the check to pay for the mailbox.

We might be able to livestream our meetings (though we would have to limit access to those who sign up.)

Mark wants outreach for educational events.

--Minutes by OSA Secretary Syd Henderson

### **Minutes of March 11 Oklahoma Space Alliance Meeting**

Oklahoma Space Alliance met March 11, 2023, at the McMurray house in Norman, Oklahoma. Attending were Clifford and Claire McMurray. Adam Hemphill, Steve Marino, John Northcutt, Tim Scott, Dave Sheely, and Syd Henderson. OSA President Clifford (Kip) McMurray presided over the meeting. He did an Update discussing links to material covered in the meeting and this is online at <https://osa.nss.org/Update2303.pdf> so I'll cover the details that aren't covered there.

This was a celebration for those who could not make it to the Christmas Party, so we called it Christmas Party II. However, we had a short program also.

The National Space Society has a new President, Isaac Arthur:

<https://space.nss.org/isaac-arthur-named-president-of-the-national-space-society/>.

We watched a video on the Chinese Lunar Lander.

There was a coolant leak on the most recent Progress Cargo Ship. This makes the theory that the coolant leak on the Soyuz attached to the ISS was caused by a micrometeorite less plausible.

India's Small Satellite Launch Vehicle failed last year because the separation shock was larger than expected and sent the satellite into salvage mode.

Intuitive Machines is now traded on NASDAQ with the symbol LUNR.

We are now up to 5300 known exoplanets. [Expect this to increase a lot in the next few years with more dedicated exoplanet detection missions, not to mention the James Webb Space Telescope.]

We saw a picture of a SpaceX Starlink launch silhouetted against the Moon.

We tuned into a Relativity Space launch attempt live. If successful, this 3D-printed rocket, Terran R, would have been the first methane-powered Rocket to make orbit, but it was called off. [They tried again on March 22. The first stage worked fine but the second stage failed to ignite. However, it was considered a good test flight.]

We have \$897.81 in our account and \$267 cash on hand for a total of \$1164.81.

At this point we paused for dinner. Afterward we watch "The Last Man on the Moon," a documentary about Eugene Cernan.'

--Minutes by OSA Secretary Syd Henderson

### **International Space Development Conference**

The 2023 International Space Conference, the National Space Society's annual conference, will be held May 25 – 28 in Frisco, Texas, a suburb of Dallas about 40 miles north of Love Field, the Dallas-Fort Worth Airport, And just north of Plano. The hotel is Embassy Suites by Hilton, Dallas-Frisco Texas. The website is <https://isdc2023.nss.org/>.

The ISDC always has a lot of speakers on space science and technology, and this year's featured speakers include retired astronaut Bonnie Dunbar; Jared Isaacman of *Polaris Dawn* fame; Dr. Pascal Lee, Chairman of the Mars Institute and Director of the Haughton-Mars Project; Isaac Arthur, the new president of the National Space Society.

Topics include: The exploration, development, and settlement of the Moon, Mars, and cislunar space, Space medicine and human health in spaceflight, Innovative spaceflight technologies, Space commercialization and infrastructure, International collaboration in space and living in space, Space debris and mediation solutions, and Space law and policy.

This year's Wernher von Braun Memorial Award has been awarded by the National Space Society to the James Webb Space Telescope Team, who will accept it at the ISDC.

"Accepting the award will be Dr. Eric Smith, the Associate Director for Research in the Science Mission Directorate's Astrophysics Division at NASA Headquarters and Program Scientist for the James Webb Space Telescope. Dr. Smith is the NASA scientist responsible for the Webb science content and is also responsible for monitoring and managing the science program for both the Webb Telescope and Hubble, ensuring their missions remain viable and true to NASA strategic objectives." (NSS announcement.)

Several members of Oklahoma Space Alliance are planning to go, and we will be working out logistics at the May 13 meeting.

## Space News

Cover: Fomalhaut (Alpha Piscis Austrini) is the eighteenth brightest star in the night sky and the only conspicuous star in the Southern Fish. It is also relatively close, being 25 light-years away, and somewhere between 100 and 300 million years old.

It has long been of interest to astronomers as it appears to be halfway to forming a planetary system. Indeed, it is one of those stars where you periodically see stories that a planet is actually hidden in its dusty cloud. What it definitely appears to have is an enormous asteroid belt which has now been imaged in detail by the James Webb Space Telescope—or rather THREE enormous asteroid belts, the largest of which would extend five times the distance to Neptune if placed within our solar system (or well outside the Kuiper Belt), and there is evidence of not one but three planets shaping these asteroid belts, perhaps as Jupiter shapes the asteroid belt and Neptune the inner regions of the Kuiper Belt.

Fomalhaut is too young and hot for these planets to have life, not to mention that large asteroid strikes on the planets would be common. However, it is fascinating to compare it to what the newborn Solar System may have looked like.

Well, Elon Musk warned us that there was only a 50-50 chance that *Starship 1* would make orbit, and he was right, although at least it didn't blow up on the launch pad. However, the power of the thrust of the rockets seriously damaged the launch pad and threw debris for miles, including apparently into the rocket. As a result, of the thirty-three engines, only twenty-seven were able to launch the rocket and the six that were out were mostly on the same half of the engine array, which affected stability, which I assume is why the second stage was unable to separate. Since *Starship* was clearly not going to be able to make orbit, it was ordered to self-destruct. Last I heard nobody was injured by debris either of the launch pad or of *Starship*.

Naturally there is a lot of second-guessing going on, not least of decisions made by Elon Musk not to use a cooling system or fire trough for the launch pad, which is usual practice. Well, that is going to change. There was also talk of using a steel launch plate (which would have to be cooled to keep it from melting). Apparently, there was a clever method of detaching the second stage that depended on the first stage operating as expected. That will obviously be rethought.

The FAA is understandably not pleased with the problems with the launch and has grounded further launches of *Starship* until SpaceX satisfies seventy-five actions to mitigate the environmental impact of *Starship* launches from Boca Chica, Texas. This will take many months to complete. There is a lawsuit by environmental against the FAA saying that the FAA didn't provide adequate environmental analysis and would have to start over. This would delay launches for years but probably would fail since the FAA has already issued a 40-page assessment and SpaceX had to satisfy seventy-five actions to mitigate the environmental impact of *Starship* launches from Boca Chica, Texas. (These actions include things like shield lights to protect turtle nesting sites and take actions to keep falcons from nesting on site. Although not one of the actions, SpaceX also agreed not to launch on Federal and State holidays.)

*JUICE*, the Jupiter Icy Moons Explorer, has been renamed Juice, which seems appropriate since the acronym really wasn't. (It would have been JuIce in any case, which is a strain on my spellcheck). It launched April 14 without incident and is now on its way to a roundabout voyage to Jupiter that includes an Earth flyby, Venus flyby, then two more Earth

flybys, This is all necessary to get it to Jupiter, Once there, it will also receive numerous gravitational assists from Ganymede and Callisto to slow it down and allow it eventually to go into Ganymede orbit. Jupiter orbit will be achieved in July 2031, but Ganymede orbit won't start until December 2034. Since *Juice*'s mission overlaps with that of the *Europa Clipper*, *Juice* will spend little time around Europa but pay a lot of visits to Callisto. Neither mission will visit Io.

*Juice* has hit one snag. The RIME (Radar for Icy Moons Exploration) antenna didn't deploy properly, and project specialists are trying to find a way for it to free itself. RIME is *Juice*'s ice penetrating radar which can penetrate five and a half miles below the surface and is essential to analyze the upper layers of Ganymede and Callisto. Another instrument, the Juice-Magnetometer (or J-MAG) also studies the interiors of the moons and will provide information on the magnetic field of Ganymede and possible subsurface oceans. It's almost certain that Ganymede has one; Callisto may have a layer of slush.

We're getting accustomed to discoveries that point to subsurface oceans inside objects in the outer solar system. Indeed, we pretty much know Jupiter's satellites Europa and Ganymede have them, and Callisto probably has something, even if it is slush. Titan likely has one, and Enceladus looks like it probably does. Farther out, Pluto seems to, and planetary scientists are looking suspiciously at other Kuiper Belt objects, Neptune's moon Triton, and the dwarf planet Ceres. Eris, Sedna and Orcus are sufficiently massive that radioactive decay may have produced oceans, and the same may be Saturn's moon Mimas, which also experiences tidal effects. However, Saturn's second largest moon, Rhea, seems to be ruled out, perhaps because it is mostly light ices.

Now we have this: <https://www.nasa.gov/feature/jpl/new-study-of-uranus-large-moons-shows-4-may-hold-water>. None of Uranus's moons are supersized like Titan or Ganymede, but four of the five largest ones (Ariel, Umbriel, Titania and Oberon) are good-sized and are the four suspected of having subsurface oceans, using data from *Voyager 2* data. The smallest of the five, Miranda, is less than half the diameter of the second smallest and is not suspected of possessing an ocean.

Of course, we can't really be certain until we send out a Uranus orbiter, and there are proposals for such, which would probably arrive well after my 100<sup>th</sup> birthday. However, China is thinking about a dual launch of a Jupiter orbiter and a Uranus flyby, which would be the first time any spacecraft has visited Uranus since 1986.

On February 8, *Nature* published an article (<https://www.nature.com/articles/s41586-022-05629-6>) on the discovery of a ring around the dwarf planet Quaoar which resides in the Kuiper belt. Discovering rings around objects in the outer solar system isn't new—all the outer planets (not counting Pluto) have them, and another dwarf planet in the Kuiper Belt, Haumea, was already known to have one. What made Quaoar's ring surprising was that it lies outside the Roche limit of Quaoar. Quaoar has a diameter of 690 miles and its Roche limit is around 1086 miles from its center. The ring is 2500 miles from Quaoar's center, well over twice the Roche limit. All other rings in the solar system are comfortably within the Roche limits of the center orbit, with the exception of some tenuous rings like Saturn's F ring.

The Roche limit is the distance within which tidal forces prevent objects from coalescing and sizeable objects disintegrate. Rings outside the Roche limit, especially as far out as this one, should coalesce into a moon within decades. And this one is not tenuous: its width is three to 180 miles wide and has enough mass to form a moon six miles in diameter. It's possible we may have caught it at just the right moment, but that would be a big coincidence.

This news came out a while ago. Now Quaoar is doing astronomers one better: it has *two* rings outside the Roche limit. The second one is 1540 miles from Quaoar's center but much less is known about it, but astronomers are really puzzled.

It's worth noting that the outer ring is in a 1:3 resonance with the rotation of Quaoar and the inner one is close to a 5:7 resonance. Haumea's ring and the centaur Chariklo's ring are both in 1:3 resonance with the rotation of the parent body (though both of these are inside the Roche limits of their parent bodies. Perhaps this resonance prevents the rings from condensing even outside the Roche limit. (For some reason, this makes me think of how Jupiter's gravitational effects keep the asteroid belt from condensing into one small planet.)

Quaoar also has a satellite, Weywot, which orbits at a distance of 8300 miles. Weywot's is in a 6:1 resonance with the outer ring, so it may be acting as some kind of distant shepherd satellite. Weywot has a diameter around 110 miles, so should be massive enough to have gravitational effects on the rings. (I think this means it is in 18:1 resonance with Quaoar's rotation, which would be odd if true.)

New data about the Moon reveals that not only does it have a liquid core, but also a solid inner core is solid, not unlike Earth's but much smaller, with a density suggesting that it is made mostly from iron. It is about 310 miles across, while Earth's inner core is 1520 miles across.

The Moon has next to no magnetic field today, but at one point it had a magnetic field 100 times greater than Earth's is today. How the Moon lost its magnetic field is a mystery, but probably is related to the slowing of its rotation and its internal cooling, though obviously it is not completely cool.

Although a lot of iron sank to the center of the Moon (as on Earth), there is also plenty in its crust and mantle. In addition to metallic iron sinking into the core, there are lots of minerals containing iron such as oxides and silicates that do not. Metals that join the iron in sinking into the core are called siderophiles, and include nickel, the platinum group metals, gold, and rhenium, which is one of the reasons these are rare in the Earth's crust and have to be supplied by meteorites (and why asteroid mining is a thing) or volcanic eruptions. Iron, therefore, is only partially a siderophile.

## Sky Viewing

**Mercury** is currently hidden in the sunrise after its May 1 inferior conjunction with the Sun. It may be visible by May 23, when it is magnitude 1 and seven degrees east of Jupiter. However, Mercury remains low in the east, being only four degrees high a half hour before sunrise. The situation improves in early June, but this is still a poor apparition.

**Venus**, on the other hand, is dominating the western sky after sunset. It is currently magnitude -4.1 and growing brighter. Venus is about as far north as it gets, which is interesting for people in Alaska for which it is nearly circumpolar (i.e., it barely sets). Unfortunately, this is also true of the Sun in Alaska this time of year. For us, Venus is some 40 degrees above the horizon at sunset with greatest elongation (45 degrees) on June 4. Venus actually gets for a while after greatest elongation (it's brightest as a fat crescent) and reaches magnitude -4.7 at the end of June, which is the brightest it or any other planet (except Earth, of course) ever gets. It's currently joining Mars Gemini but isn't really that close to it. In June Venus passes through the famous Beehive Cluster in Cancer, which is fortunate because Cancer is the second dimmest constellation in the Zodiac (after Capricornus). To see the cluster, follow Venus in the second week of June.

**Mars** is currently in the upper part of Gemini close to the heavenly twins, Castor and Pollux. On May 15, Mars will be in a straight line them. The order from left to right is Mars, Pollux and Castor, with Pollux the brightest of the three, and Mars in-between. (Castor, however, is Alpha Geminorum because you always hear the pair called Castor and Pollux.) Mars is currently magnitude 1.4, far dimmer than it was six months ago, which is not surprising because it is on the far side of the Sun. Mars also goes into Cancer in June but somehow manages not to have a conjunction with Venus. Mars will continue to grow dimmer and more pathetic, but it doesn't actually have a conjunction with the Sun until November.

**Jupiter** has now passed through conjunction and is a morning star, but is very low on the horizon before sunrise. The outer planets tend to rise a couple of hours earlier each month, and Jupiter is no exception. It rises at 4:00 a.m. on June 1, and a couple of hours earlier at the end of the month. The Moon occults Jupiter on the morning of May 17 from much of the United States, but not Norman.

**Saturn** is only magnitude 1.0 and is now rising about 4:00 in the morning and will rise at 2:00 a.m. at the end of May. By the end of June, it will rise around midnight. Even then, it will only be magnitude 0.8, but it's in Aquarius, and is the brightest object there or in the neighboring constellations of Pisces, Capricornus or Pegasus. Its only competition is Fomalhaut directly south of it in Piscis Austrinus, and that will be low in the south in June.

**Uranus** was in conjunction with the Sun on May 9 and is not visible even via telescope until June.

**Neptune** was in conjunction with the Sun on March 15 and is now visible by telescope or strong binoculars in the morning sky.

No meteor showers for the next two months and we have to wait on comets.

Data on the planets come from the May and June issues of *Sky and Telescope* and *Astronomy* and from their websites.

## Viewing Opportunities for Satellites (May 13 – June 13, 2023)

You can get sighting information at [www.heavens-above.com](http://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 [sky-andtelescope.com/observing/almanac](http://sky-andtelescope.com/observing/almanac). You can also get data at <https://spotthestation.nasa.gov/sightings/>.

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

The “mag.” beside the date indicates the brightest magnitude the satellite gets during the pass. All the ISS passes get between -3 and -4, which is brighter than Jupiter ever gets, but not quite as bright as Venus.

Missions to and from the International Space Station and *Tiangong* can change their orbits. There is a Progress resupply mission to the ISS set for May 24, and a SpaceX resupply mission on June 3. The next mission to *Tiangong* launches sometime in May. There are none to Hubble in the near future. Also note that the ISS (and presumably *Tiangong*) sometimes have to alter orbits to avoid space debris. Hubble is high enough that this is less of a concern.

The information below is from Heavens Above. There are no good passes of the Hubble Space Telescope

Key: Position is measured in degrees clockwise from north. That is, 0° is due north, 90° is due east, 180° is due south, and 270° is due west. Your fist held at arm's length is about ten degrees wide. "Elevation" is elevation above the horizon in degrees. So, to view the International Space Station at 9:0 p.m. on June 2, measure about four fist-widths north of due west then one fist-width above the horizon.

ISS 5/13/23 mag. -3.8

Time	Position	Elevation
9:09 p.m.	320°	10°
9:13:30	40	58*
9:16	115	10

\*Passes near & north of Arcturus

ISS 5/15/23 mag. -2.3

Time	Position	Elevation
9:09 p.m.	250°	10°*
9:12	222	41
9:15	34	10

\*Passes very close to Venus

HST 5/18/23 mag. 1.7

Time	Position	Elevation
9:38 p.m.	235°	10°
9:41:08	174	29
9:42:34	138	23

Vanishes into Earth's Shadow

HST 5/19/23 mag. 1.7

Time	Position	Elevation
9:23 p.m.	238°	10°
9:26:43	176	30
9:28:07	124	17

Vanishes into Earth's Shadow

HST 5/30/23 mag. 1.7

Time	Position	Elevation
9:09 p.m.	241°	10°
9:12	178	31
9:16	117	12

ISS 5/30/23 mag. -3.6

Time	Position	Elevation
9:56 p.m.	319°	10°
9:59:06	40	62
10:00:30	111	31

Vanishes into Earth's shadow.

ISS 5/31/23 mag. -2.2

Time	Position	Elevation
9:07 p.m.	330°	10°
9:10	36	33
9:13	103	10

Tiangong 5/31/23 mag. -2.0

Time	Position	Elevation
Emerges from Earth's shadow.		
5:09:49 a.m.	225°	23°
5:11:31	152	58
5:15	70	10

Tiangong 6/1/23 mag. -1.4

Time	Position	Elevation
5:42 a.m.	265°	10
5:45	341	47
5:48	57	10

Tiangong 6/2/23 mag. -2.3

Time	Position	Elevation
Emerges from Earth's shadow.		
4:41:29 a.m.	253°	49°
4:42:12	335	83
4:45:19	64	10

ISS 6/2/23 mag. -3.7

Time	Position	Elevation
9:06 p.m.	310°	10°
9:09	225	77
9:12	138	10

Tiangong 6/11/23 mag. -1.5

Time	Position	Elevation
4:50 a.m.	301°	10°
4:53	21	57
4:56	101	10
5:29	136	10

## Programming Notice: NASA TV on the Web

Watch NASA TV (Public, Media and Education Channels) on your computer using Flash, Windows or Quick-Time at <http://www.nasa.gov/multimedia/nasatv/index.html>.

NASA TV Schedules are available at <http://www.nasa.gov/multimedia/nasatv/schedule.html>.

May 12: 10:30 a.m. coverage of Russian spacewalk to deploy and activate the radiator for the Nauka Module. Spacewalk should begin at 10:55 a.m. and last until around 5:55 p.m.

May 24: 7:30 a.m. Launch of ISS Progress 84 cargo ship from Baikonur Cosmodrome in Kazakhstan. The actual launch is 7:56 a.m. 10:30 a.m. Docking coverage for Progress 84. Actual docking is at 11:20 a.m.

There will also be coverage of the SpaceX cargo launch at 11:34 a.m. on June 3 but it isn't on the schedule yet.

## Calendar of Events

Sometime in 2023: launch of *#dearMoon*, which will carry Japanese billionaire, Yusaku Maezawa, two crew members, and eight artists on a lunar free-return mission. For more information, visit [https://en.wikipedia.org/wiki/Dear-Moon\\_project](https://en.wikipedia.org/wiki/Dear-Moon_project)

Sometime in 2023: First flight of Blue Origin's *New Glenn* orbital rocket. For more information, see [https://en.wikipedia.org/wiki/New\\_Glenn](https://en.wikipedia.org/wiki/New_Glenn).

May: fifth crewed launch to the Tiangong space station. For more information, see [https://en.wikipedia.org/wiki/Shenzhou\\_16](https://en.wikipedia.org/wiki/Shenzhou_16).

May 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](http://www.okcastroclub.com) for details.

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

May 17: Launch of *Axiom-2* 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\\_Mission\\_2](https://en.wikipedia.org/wiki/Axiom_Mission_2). [Axioms 3 and 4 should also launch this year.]

May 25 – 28: ISDC 2023, the International Space Development Conference, Embassy Suites by Hilton, Dallas-Frisco, Texas. Information at <https://isdc2023.nss.org/>

May 28: Mercury is at greatest western elongation, 24.9° from the Sun (so can be seen before sunrise).

June: Launch via Falcon 9 of the *Nova-C* lander and other cargos to the Lunar South Pole.

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

June 4: Venus is at greatest elongation, 45.4 degrees east of the Sun (so can be seen after sunset).

June 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](http://www.okcastroclub.com) for details.

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

June 10: Falcon 9 rideshare mission carrying about 30 small satellites into orbit.

June 16: Launch of Heinrich Hertz (H2Sat) and Syracuse 4B communication satellites. This is only notable because it is the last Ariane 5 launch.

Summer of 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.

July: India launches Chandrayaan-3, which will include a lander and a long-lived rover which will explore craters around the Moon's South Pole in search of ice. See <https://en.wikipedia.org/wiki/Chandrayaan-3>.

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

July: Launch of the European Space Agency's *Euclid* space telescope. This will map the distribution of dark matter and search for evidence of dark energy. The Euclid website is <https://sci.esa.int/web/euclid>. This is one of the missions that had to find a new ride after the Russian invasion of Ukraine.

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



July 13: Launch of *Luna 25*, the first mission of Russia's Luna-Glob program, landing near Bogulswasky crater. For more information, see [https://en.wikipedia.org/wiki/Luna\\_25](https://en.wikipedia.org/wiki/Luna_25).

July 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](http://www.okcastroclub.com) for details.

July 21 [Moved from April]: First crewed test launch of *Boeing Starliner-1* to the ISS.

July 30-31: Peak of Southern Delta Aquariid meteor shower. Moon, alas, will be almost full.

August: [Postponed from 2022.] Launch of SLIM, the Smart Lander for Investigating Moon, a Japanese lunar lander. Another JAXA spacecraft, *XRISM*, the X-Ray Imaging Spectroscopy Mission (pronounced "krism") launches on the same flight. For more information, see [https://en.wikipedia.org/wiki/Smart\\_Lander\\_for\\_Investigating\\_Moon](https://en.wikipedia.org/wiki/Smart_Lander_for_Investigating_Moon) and [https://en.wikipedia.org/wiki/X-Ray\\_Imaging\\_and\\_Spectroscopy\\_Mission](https://en.wikipedia.org/wiki/X-Ray_Imaging_and_Spectroscopy_Mission).

August 11: 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](http://www.okcastroclub.com) for details.

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

August 12 – 13: Peak of Perseid meteor shower. This may be good since the Moon is a thin crescent.

August 13: Venus is in inferior conjunction with the Sun.

August 17: Crew 7 launch to the ISS by SpaceX.

September [Moved from July]: Launch of *Polaris Dawn* flight carrying Jared Isaacman and four other civilians into space. [https://en.wikipedia.org/wiki/Polaris\\_Dawn](https://en.wikipedia.org/wiki/Polaris_Dawn)

September 8: Oklahoma City Astronomy Club meets at Science Museum Oklahoma. 7:00 p.m., followed by a talk at about 7:45 p.m. See [www.okcastroclub.com](http://www.okcastroclub.com) for details.

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

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

September 24: *OSIRIS-REx* returns samples from Asteroid Bennu.

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

Fourth quarter of 2023 [Moved from April]: April Maiden flight of Ariane 6.

Fourth quarter of 2023: First (uncrewed) *Gaganyaan* flight test. For more information, see [https://en.wikipedia.org/wiki/Gaganyaan\\_1](https://en.wikipedia.org/wiki/Gaganyaan_1)

October 10: Launch of *Psyche*, which will orbit a large metallic asteroid also named Psyche. See [en.wikipedia.org/wiki/Psyche\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Psyche_(spacecraft)). The *Janus* mission, which will send twin probes *Serenity* and *Mayhem* to separate asteroids (yet to be determined), will launch on the same flight. For more information, see [en.wikipedia.org/wiki/Janus\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Janus_(spacecraft)).

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

October 14: Annular eclipse of the Sun. The path where it is annular extends from the coast of Oregon, northern Nevada, Utah, central New Mexico, and southwestern Texas (including Austin and San Antonio), thence lengthwise through Yucatan and Central America, then Colombia and northern Brazil. This will be partial from Oklahoma with 80% of the Sun covered. This makes a good prelude to the total eclipse the following April.

October 20: Peak of Orionid meteor shower.

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

November: Second Nova C mission carrying the *Trailblazer* lunar orbiter, the Micro-Nova lunar hopper, and two lunar rovers for various companies. In addition, PRIME-1, the Polar Resources Ice Mining Experiment 1, flew on this flight.

November (moved from October): 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.

November: Launch of *Axiom-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](https://en.wikipedia.org/wiki/Axiom_Space).

November: Sixth crewed flight to the Tiangong space station.

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

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

November 17 – 18: Peak of Leonid meteor shower.

Mid-December: First ISS Cargo Resupply mission for Dream Chaser.

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

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

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

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

Sometime in 2024: First launch of Firefly's *Blue Ghost* lunar lander. For more information, see [https://en.wikipedia.org/wiki/Firefly\\_Aerospace#Blue\\_Ghost\\_lunar\\_lander](https://en.wikipedia.org/wiki/Firefly_Aerospace#Blue_Ghost_lunar_lander).

Sometime in 2024: JAXA launches *DESTINY+*, an asteroid flyby mission to Phaethon, the parent of the Geminid meteor shower. It will arrive there in 2028. For more information, see [en.wikipedia.org/wiki/DESTINY%2B](https://en.wikipedia.org/wiki/DESTINY%2B).

Sometime in 2024: India launches Mars Orbiter Mission 2 (MOM 2). For more information, see [https://en.wikipedia.org/wiki/Mars\\_Orbiter\\_Mission\\_2](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.

Second quarter of 2024: A SpaceX Nova-C mission to the moon takes Intuitive Machines' IM-3 lander, NASA's Lunar Vertex rover, Lunar Outpost's M2 MAPP rover, and several NASA Cadre rovers.

April 8, 2024: Next total eclipse of the Sun visible in the United States. This one will be visible on a path through northern Mexico (making landfall opposite the tip of Baja California), passes through Texas (including Dallas, Arlington, and Waco), touches the southeastern corner of Oklahoma, then crosses Arkansas, eastern Missouri, Illinois, western Kentucky, Indiana, Ohio (including Cleveland), Erie in Pennsylvania, upper New York (including Buffalo and Niagara Falls), Burlington in Vermont, New Hampshire, and Maine, then into Canada.

May 2024: Launch of *Chang'e 6*, China's second lunar sample return mission, this time to the Apollo Basin on the far side of the Moon.

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

Mid-2024: Launch of *Axiom-* 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](https://en.wikipedia.org/wiki/Axiom_Space).

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

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

September 2024: Launch of Japan's *Martian Moons Exploration* (MMX) which includes a Phobos lander and sample return. For more information, see [https://en.wikipedia.org/wiki/Martian\\_Moons\\_eXploration\\_\(MMX\)](https://en.wikipedia.org/wiki/Martian_Moons_eXploration_(MMX)).

Fourth quarter of 2024: Launch of the Mission Robotic Vehicle (MRV) which carries the RSGS (Robotic Servicing of Geosynchronous Satellites) to attach jet packs to remove dying satellites from orbit.

October 2024: Launch of the *Hera* asteroid orbiter by the ESA, which contains the *Juventas* and *Milani* asteroid probes. Destination is the binary asteroid Didymos/Dimorphos to evaluate the results of the DART asteroid impact mission.

October 2024: Launch of *Europa Clipper* orbiter. For more information, [https://en.wikipedia.org/wiki/Europa\\_Clipper](https://en.wikipedia.org/wiki/Europa_Clipper).

November 2024 (moved from May): *Artemis 2*, the first crewed test flight of SLS and Orion. This will be a free-return mission: that is, it will loop around the Moon without landing.

November 2024: Launch of the first two modules of the Lunar Orbiter Platform- Gateway. These were originally going to be launched on separate spacecraft but are now bunked together.

November 2024: Launch of NASA's *VIPER* lunar rover, which will hunt for ice near the Nobile Crater at Moon's South Pole. VIPER is landing aboard Astrobotic's *Griffin* lunar lander. They leave Earth aboard a Falcon 9.

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

December 24, 2024: Parker Solar Probe (formerly Solar Probe Plus) makes its first pass through the outer corona of the Sun. For more information, see <http://parkersolarprobe.jhuapl.edu>.

Sometime in 2025: India launches its first crewed orbital flight *Gaganyaan-3*

Sometime in 2025: China launches the *Chang'e 6* lunar sample return mission. For more information, see [https://en.wikipedia.org/wiki/Chang%27e\\_6](https://en.wikipedia.org/wiki/Chang%27e_6).

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

Sometime in 2025 [moved from 2024]: Israel launches its *Beresheet 2* lander and orbiter on the Moon. For more information, see [en.wikipedia.org/wiki/Beresheet\\_2](https://en.wikipedia.org/wiki/Beresheet_2).

Sometime in 2025: first uncrewed test launch of *Orel*, Russia's new crewed spacecraft, with first crewed launch later in the year. For information, [https://en.wikipedia.org/wiki/Orel\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Orel_(spacecraft)). This is the first flight for Russia's Angara A5P spacecraft.

Sometime 2025: First crewed flight of Russia's *Orel* (formerly called *Federatsiya*), destined for the ISS.

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

May 2025: Launch of Tianwen-2 (formerly Zheng He), China's asteroid sample return mission and comet orbiter.

Fourth quarter of 2025: Launch of the Space Entertainment Enterprise's SEE-1 inflatable space habitat docked to the Axiom segment of the ISS.

December 2025: Launch of *Artemis 3*, which will be the first crewed lunar landing since 1972.

December 2025: *BepiColombo* arrives at Mercury orbit.

Sometime in 2026: Launch test of China's Long March 5DY, which will eventually carry Chinese astronauts to the Moon.

July 2026: *Hayabusa 2* flies by asteroid 2001 CC<sub>21</sub>.

Fourth quarter of 2026: China launches the lunar mission *Chang'e 7*, which include an orbiter, a rover and a hopping probe.

October 2026: Launch of the *Nancy Grace Roman Space Telescope* [formerly known as WFIRST]. For more information, see [https://en.wikipedia.org/wiki/Nancy\\_Grace\\_Roman\\_Space\\_Telescope](https://en.wikipedia.org/wiki/Nancy_Grace_Roman_Space_Telescope).

Sometime in 2027: First test flight of China's manned launch vehicle for lunar missions. There doesn't seem to be a definite name.

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](https://en.wikipedia.org/wiki/Russian_Orbital_Service_Station).

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

June 2027: Launch of *Dragonfly*, the Titan helicopter mission.

August 12; 2027: *Lucy* flies by asteroid 3548 Eurybates in its first encounter with a Trojan asteroid. It will fly by at least 3 more Trojans in 2027 and 2028.

Sometime in 2028: ESA launches the *ExoMars Mars Rover*, which has been christened *Rosalind Franklin*. For more information, visit <https://en.wikipedia.org/wiki/ExoMars>. Note: this is the mission most affected by Russia's invasion of Ukraine, since they were supposed to supply the landing platform.

Sometime in 2028: Launch of *Chang'e 8*, which will include a lander, rover and a 3D printing experiment using lunar resources.

Sometime in 2028: Launch of the *Sample Retrieval Lander* to Mars. This is part of a joint NASA/ESA mission and will include Ingenuity class helicopters.

First half of 2028 (postponed from 2026): Launch of the *NEO Surveyor* which will be able to detect more than 90% of near-earth objects greater than 460 feet in diameter. For more information, see [https://en.wikipedia.org/wiki/NEO\\_Surveyor](https://en.wikipedia.org/wiki/NEO_Surveyor).

First quarter of 2028: Launch of the *Emirates Asteroid Mission*.

April 18, 2028: *Lucy* encounters asteroid 11351 Leucus, its first Trojan encounter.

September 2028: Launch of *Artemis 4*, a Lunar Gateway expedition.

November 2028: Launch of China's *Tianwen-3* Mars sample return mission.

Sometime in 2029: Launch of the *ARIEL Space Telescope* and the *ESA/JAXA Comet Interceptor* mission via Ariane 62.

Sometime in 2029 (moved from 2028): Launch of *VERITAS* orbiter to Venus.

Sometime in 2029: The *Psyche* asteroid probe arrives at the asteroid 16 Psyche. [This is assuming a 2023 launch.] For more information, visit [https://en.wikipedia.org/wiki/Psyche\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Psyche_(spacecraft)).

Sometime in 2029 [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).

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

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

September 2029: Launch of Artemis 5 to the Moon.

October 2029: *Juice* achieves Jupiter orbit. [See 2022.]

Sometime in 2030: 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.

Sometime in 2030: Launch of *Tianwen-4*, which includes a Jupiter orbiter and a mission to Uranus.

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

September 2031: Launch of *Artemis 7* to the Moon.

Sometime in 2033: *Juice* achieves Ganymede orbit. [See 2022.]

December 2034: *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, 2023

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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](http://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](http://www.tulsaairandspacemuseum.com). Phone (918) 834-9900.

The Mars Society address is The Mars Society, 11111 West 8<sup>th</sup> Avenue, Unit A, Lakewood, CO 80215. Phone: (303) 980-0890 Their web address is [www.marsociety.org](http://www.marsociety.org).

The National Space Society's Headquarters Executive Director e-mail [nsshq@nss.org](mailto:nsshq@nss.org). The Chapters Coordinator is Bennett Rutledge 720-641-7987, [rutledges@chapters.nss.org](mailto: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](http://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](http://www.planetary.org). E-mail is [tps@planetary.org](mailto:tps@planetary.org).

NASA Spacelink BBS 205-895-0028. Or try [www.nasa.gov](http://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](http://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. 8<sup>th</sup> Ave, Unit A, Lakewood, CO 80215.

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