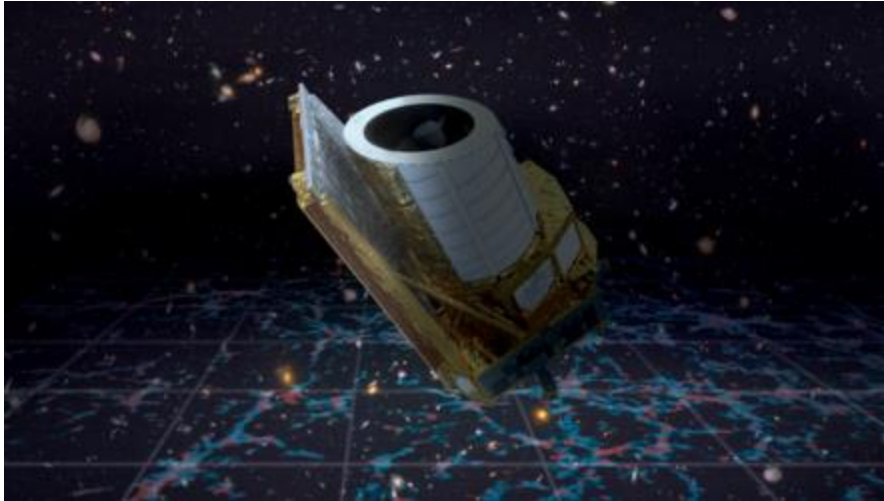


# **OKLAHOMA SPACE ALLIANCE**

## **OUTREACH – July 2023**

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

Oklahoma Space Alliance will meet at the  
at the room next to Norman Computer  
at 2:00 p.m. on July 8, details inside



**Euclid Space Telescope (ESA Image)**

## OKLAHOMA SPACE ALLIANCE OUTREACH July 2023

### July Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, July 8, 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://tinyurl.com/y2qtab28>. If the link doesn't work, call Clifford McMurray, President 405-329-4326 (H), 405-863-6173 (C) (e-mail [cliffmcmurray@hotmail.com](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 July 8, 2023, 2:00 p.m. (tentative)

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

### Minutes of June 10 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met June 10, 2023, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending in person were Clifford and Claire McMurray. Charles ?, Mark Deaver, Adam Hemphill, Clark Morter. 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/Update2306.pdf> so I'll cover the details that aren't covered there.

We watched part of the return of the Axiom-2 (Ax-2) mission, The ship used to pull Ax-2 out of the water also has a pad for SpaceX stages to land on, but obviously not used for the Dragon capsule (which I believe has to splash down anyway). Later we watched the docking of Ax-2 with the space station.

One of the new Chinese astronauts on *Tiangong* is their first payload specialist. They are keeping a crew capsule on standby in case of emergency (as well as the capsule attached to *Tiangong*. This seems prudent, given the problems the Soviets had when the coolant went out on the *Soyuz* that was supposed to take three astronauts home and they had a sudden extension of their stay.

The first Chinese manned mission to the Moon will land two astronauts on the surface and one in orbit, just like the *Apollo* missions did. A stay of six hours on the surface is anticipated [but this is far enough in the future that plans can change.]

Peggy Whitson is the first woman to command a private space mission. [She was also ISS commander twice and once held the record for longest stay in space by a woman and prior to Wally Funk was the oldest woman to fly in space. I believe she is still the oldest woman to orbit the Earth,

The Blue Moon [Blue Origin] moon lander will have a stage that can be launched for refueling in orbit by a tanker being built by Northrup Grumman. [All still to be built-SFH.] Blue Moon will be using liquid hydrogen, in contrast with Starship, which uses methane.

We watched a video of the Chinese spacewalk.

Stratolaunch's latest cargo, Talon-0 doesn't have an engine [hence the zero] but is a glider prototype of a hypersonic aircraft that will be launched with an engine by Stratolaunch later this year,

Space startups Momentus and Astroscale, who hope to reboost Hubble and other spacecraft such as the Chandra X-Ray Observatory, are also having cash flow problems

We watched a trailer for "Stars on Mars" a reality show filmed in the Australian outback that simulates a Mars colony using celebrities in a "Survivor"-type scenario. I guess if people get voted out the airlock. William Shatner is the host.

The James Webb Space Telescope detected a huge plume erupting from Saturn's satellite Enceladus. We watched a YouTube video on tethered ring launch, which is a concept to raise a ring around the Earth.

We also watched a YouTube video on all you need to understand orbital mechanics.

We now have \$826.06 in the checking account and \$267 in cash.

--Minutes by OSA Secretary Syd Henderson

### **Minutes of May 13 Oklahoma Space Alliance Meeting**

Oklahoma Space Alliance met May 13, 2023, at the Cyber Hall and Gaming Lounge at Norman Computers in Norman, Oklahoma. Attending in person were Clifford and Claire McMurray. Mark Deaver, Russ Davoren, Adam Hemphill, Charles Miller, Clark Morter, John Northcutt, Dave Sheely, Syd Henderson and a person named Kelly whose last name I didn't catch. 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/Update2305.pdf> so I'll cover the details that aren't covered there.

Clifford and Claire McMurray went to the test launch of SpaceX's *Starship* on South Padre Island in Texas. We watched a video of the launch and subsequent explosion.

Virgin Orbit was a billion dollar in debt.

Relativity Space will have its first launch in 2026.

The United Arab Emirates' Rashid Lunar Rover was also lost when *Hakuto-R* crashed on the Moon.

We watched a video of the launch of Sawn Aerospace's MK-11 Aurora spaceplane.

We watched a video of *Ingenuity's* 47<sup>th</sup> flight taken by the camera on the *Perseverance* Rover. *Ingenuity* is now up to more than 50 flights.

Vast Space LLC hopes to launch its 70 cubic meter space station *Haven-1* in 2025. Vast eventually wants a space station that will produce "gravity" by spinning. We watched a video on *Haven-1*.

The NASA 2024 contains \$140 million for eventually de-orbiting the International Space Station.

Space Force should have its mission extended to tracking Near-Earth Objects.

We may have a barbecue after a future meeting.

--Minutes by OSA Secretary Syd Henderson

### **Minutes for the March 27 Chapters Assembly Meeting (edited for length)**

Whirlaway Room of the Embassy Suites by Hilton, Dallas-Frisco, Texas, USA (at International Space Development Conference)

Attending: Mario Anzalotti - NSS Phoenix; Donnie Lowther DC-L5; Bennett Rutledge - Denver NSS; Prathmesh Barapatre, NSS Mumbai Chapter; Sydney Henderson, Oklahoma Space Alliance NSS. ; Larry Ahearn NSS VP Chapters; Jeffrey Liss. Illinois North Shore NSS ; George Cooper Cuyahoga Valley Space Society; Sean Freeman, South Central Region Coordinator; Perri Doutré - Colorado; Gerald McLaughlin; Joseph Bland, President, Sacramento L5; Avinash Shirode - Nashik India - Representing; Dave Stewart - Seattle; Gerald McLaughlin DC L5; Jan Roston Sacramento.; Sean Freeman, South Central Coordinator ( Recording Secretary Pro Tem); William Brown - South Texas; OmPrakash G. Kulkarni, Nashik (India) chapter ; Jan Roston -Sacramento L5; Bruce Mackenzie - ; Anita Gale - CEO, NSS USA;

## 2. Approval of the Agenda - Substitute Agenda by Mr. Bland -

Regarding the NSS Chapters' Assembly Agenda Item order:

I would move that these agenda items need major restructuring by importance. Accordingly, following is my suggestion for a revised agenda. I also hereby request to have this order voted on immediately following Roll Call.

- I. Roll Call
- II. Vote on Agenda Item order
- III. Approval of the Minutes.
- IV. Election of the NSSCA Chair.
- V. Official election of the NSSCA Executive Secretary
- VI. Presentation of NSS Chapter Awards\*
- VII. Old Business
- VIII. New Business

(Seconded by Mr. Jeffery Liss)

Motion passes as above agenda to be followed

[...]

## 6. Presentation of NSS Chapter Awards

Awards announced at the NSSCA Meeting by Mr. David Stuart is as follows:

- Middle Tennessee Space Society - Special Merit Outstanding Outpost
- NSS Space and Astronomy Society of NW Jersey - Special Merit Radio Podcast
- North Huston Space Society - Special Merit Best Small Chapter
- NSS South Texas - Special Merit Best Student Chapter
- Guayaquil Space Society - Special Merit 4500 Club for the future Cards Gathered and Sent
- NSS (USA) - Mumbai Chapter - Special Merit Outstanding International Chapter
- Sacramento L5 Society - Special Merit Breakfast on the Moon Apollo Celebrations
- DC L5 - Honorable Mention Post Covid Activism
- Iowa Chapter of NSS - Honorable Mention Post Covid Activism
- San Antonio Space Society - Honorable Mention Post Covid Activism
- Phoenix Space Society - Honorable Mention Post Covid Activism
- Space Nursing Society - Honorable Mention Post Covid Activism
- Oregon Space Society - Honorable Mention Post Covid Activism

## New Business:

Why Chapter Members are unable to join NSS? What happens when you tell someone to ask to join the chapter, what response chapters have received?

Proposed by Mr. Jeffery Liss

Followed up with discussion on how other chapters are getting people to sign up for NSS Membership or why they should follow that particular chapter too.

Felicitation of NSSCA Chair

Felicitation of NSSCA Chair, Mr. Bennett Rutledge done by Mr. Avinash Shirode

## Space News

Several anniversaries this month. Kennedy Space Center was established on July 1, 1962, and became the main center for America's human spaceflight in 1968 although as the Mercury Control Center and then the Launch Control Center it had been handling manned spaceflight since the beginning. Kennedy Space Center is on Merritt Island at Cape Canaveral. From 1963 to 1973, the cape itself was re-named Cape Kennedy, but the name change wasn't popular, and the Florida state legislature changed it back in 1973, and the Federal government said okay.

And, of course, July 20 is the 54th anniversary of the *Apollo 11* landing on the Moon.

The August issue of *Astronomy* is its 50<sup>th</sup> anniversary issue which a lot of perspectives on how much astronomical photography has changed over the years. Amateur photographs from even ten years ago would no longer be acceptable and the Hubble and Webb Space Telescope and adaptive optics on land telescopes have revolutionized astronomy. Not to mention that 50 years ago, *Pioneer 10* had not flown by Jupiter and *Pioneer 11* Jupiter and Saturn, let alone *Voyager 1* and 2.

The European Space Agency's *Euclid* space telescope was launched successfully at 10:11 CDT on July 1 via a SpaceX Falcon-9 rocket. As of this writing, the launch and separation appear to have gone flawlessly and it is on its way to the Earth-Sun L2 point where it will join the James Webb Space Telescope, the Gaia exoplanet-searching probe, and The Russian/German Spektr-RG. Like them, it will achieve a halo orbit around the L2-point, which is more stable than being at L2 itself.

*Euclid*'s mission is far different from those missions: its duty is to map the effect of dark matter in as much of the sky as possible. This means it will photograph a third of the sky, that part that is not blocked by dust in the Milky Way or debris in the Solar System, or nearby galaxies. This is a much larger field of study than the Webb Telescope, but less detailed. It reminds me of the difference between the Kepler and TESS missions. You won't get the spectacular images of Hubble and Webb, but you will get a 3D map of the matter distribution of a good part of the Universe. The mission is expected to take ten years with six years for the initial survey.

*Euclid* was fifteen years from its origin as a combination of two mission concepts called Dune (Dark Universe Explore) and Space (Spectroscopic All-Sky Cosmic Explorer), which resulted in it using complementary methods of investigating dark matter. The mission was chosen in 2011 and was supposed to launch in March 2023 by Ariane using a Soyuz spacecraft. This opportunity suddenly disappeared when Russia invaded Ukraine and the ESA had to find another launch vehicle. Since the Ariane 5 rocket was being retired and Ariane 6 was not finished, and ULA was full up, the ESA had to make arrangements for a launch with Space X. Given the Falcon 9's reliability, this was a clear and logical choice.

It will take a month for *Euclid* to reach orbit around the Sun-Earth L2 point, and, like Webb, it will take months more to calibrate instruments. . Data will be from the near infrared to the green part of the spectrum Unlike Webb, it will not be available for individual science research; it is instead a general survey type of satellite with a six-year-long particular task: to break its third of the sky into small areas that in which it will map all the galaxies it can find down to a trillionth the magnitude of the Andromeda Galaxy (or, in other words, magnitude 33). As Becky Smethurst ("Dr. Becky") put it, it is essentially doing for galaxies what the European Space Agency's Gaia mission is doing for stars in our own Milky Way."

It is estimated that the first big chunk of data will be released around the end of 2025, and regularly thereafter. This will serve several purposes, including a thorough catalog of galaxies in a full spectrum of evolutionary stages, and a map of where the dark matter is, both from how it affects the rotation within the galaxies and how its gravity distorts the universe beyond them. This is best known in the special case of gravitational lenses, but we can also see distortion in the shapes of galaxies behind a less massive object. Since we will be mapping galaxies out to ten billion light years and measuring their red shifts, we will be able to tell how many galaxies there are at each distance which in turn gives us a history of the expansion of the Universe over the last ten billion years. This, in turn, helps us explore dark energy as well as dark matter. [And if it determines the expansion of the universe isn't increasing, it could eliminate even the need for dark energy.]

In a sort of complementary discovery beating Euclid, scientists have discovered evidence of very low-frequency gravitational waves traversing the Universe. It is believed that these waves originate from the mergers of supermassive black holes in the center of galaxies. To my surprise, these were discovered from changes in the timing of pulsars. In essence, they used the pulsars as gravitational wave antennas.

Astronomers' complaints about Starlink satellites ruining their observations are a long way to being answered by the new generation of satellites, which are larger reflect sunlight into space rather than to the ground, making them one twelfth as bright.

Now if only the builders of other flotillas of communications satellites are paying attention.

## Sky Viewing

The next two months feature one minor shower, the **Alpha Capricornids**, one medium-sized shower the Southern **Delta Aquariids**, and one major shower, the **Perseid Meteor Shower**. The first two both peak in late July, with the Southern Delta Aquariids peaking on July 30 with 12 – 20 per hour, and the Alpha Capricornids on July 31 with only about five. These showers actually have shallow peaks and both have radiants in the southern part of the sky, so you can really look for them at the same time. The best time to look is a few hours before dawn since the Moon will interfere in the evening.

The Perseids, on the other hand, get up to a hundred meteors per hour and this year the Moon will not interfere at all, being a very thin crescent that rises a couple of hours before dawn. I've seen them from a dark park in the center of Norman, but there's more light pollution now so I'd advise getting a few miles away from the city. The peak is on the night of August 12 – 13, and the radiant is in the north near Cassiopeia. The Perseids tend to have larger fragments than many meteor showers, so they tend to be brighter. It's also possible to see meteors a few mornings before and after the peak.

The **Moon** will occult Antares on the evening of August 24 for most of the United States, including Oklahoma. Be on the lookout about 8:00 p.m. The occultation should last about an hour. The Moon, by the way, can occult several first magnitude stars: Spica, Regulus, Aldebaran and, as here, Antares. It cannot occult Pollux, the other first magnitude star in the Zodiac, because it's too far north. The Moon can also occult most planets.

**Mercury** was in superior conjunction with the Sun on June 30 so won't be visible in the early part of July. However, Mercury is brighter on the far side of its orbit and will be visible as soon as mid-month. By July 20, it will be magnitude -0.4 and appear about a fist-width's northwest of Venus and about ten degrees above the horizon an hour after sunset. On July 25 it will be magnitude -0.1, but will also be five degrees due north of Venus.

On July 28, Mercury has a conjunction with the first magnitude star Regulus in Leo. It will be only a tenth of a degree south on Regulus, which is a fifth of the apparent diameter of the Moon. Mercury, at magnitude 0.0, will easily be the brighter of the two, but they will be setting only an hour after the Sun and may be difficult to see. Still, Mercury reaches its greatest elongation on August 9 on its way to inferior conjunction with the Sun on September 6.

**Venus** is maximum brightness (-4.7) on July 7 and dominates the western sky after Sunset (except for the Moon, of course). It is not far below the Sickle asterism in Leo, which is where Mars is now (see below). Unlike Mercury, Venus is brightest in the weeks after Greatest Elongation, when it is a fat crescent. This can only last for a short time because eventually the crescent will rapidly get thinner over the next month as Venus nears inferior conjunction with the Sun on August 17. By the end of this month, it will be setting only 25 minutes after sunset, and at the end of August it will be rising 25 minutes before the Sun.

**Mars** is also in Leo and in early July is close to Regulus, the first-magnitude star in the Sickle asterism in Leo. Indeed, on the nights of July 9 and 10, Mars is only 0.7 degrees from Regulus, which is just over the apparent diameter of the Moon. It says a bit about how far Mars has fallen that Regulus is the

brighter of the two. This is because Mars is on the far side of its orbit and approaching a conjunction with the Sun in November. (Mars moves slowly across the sky since its orbit is next beyond Earth's Venus likewise takes a long time between conjunctions because it's next in.) The pair is to the upper left of Venus.

Mars will still be magnitude 1.8 in mid-August but that's about the last time you'll be able to see it this year, as it is also setting about an hour after the Sun. After that, it will be lost in twilight.

**Jupiter**, in contrast, is getting easier to see. It's still a morning star, rising about 1:30 a.m. and shining at magnitude -2.2. By the end of July, it will be rising around midnight and be a bit brighter at magnitude -2.4 and by the end of August, it will be rising around 10:00 p.m. It's in the constellation Aries through August if you ever want to locate that constellation, but it is on the opposite side of the constellation from its semi-bright stars.

**Saturn** is only magnitude 0.8 and rises around 11:00 p.m. It will be gradually getting brighter through July and August as it approaches opposition on August 27. Even then it will only be magnitude 0.4. This is because the rings will be tilted only eight degrees from our point of view and they add significantly to Saturn's brightness when their tilt is greater, as it was a few years ago. Saturn's rings will be edge-on in a few years, which means the planet won't be as bright, but it will be a lot easier to see its satellites.

**Uranus** is in Aries with Jupiter, but west toward the border with Taurus. Indeed, it is gradually moving toward Taurus but won't actually reach it for another year. This is a rather dim region of the sky, and Uranus is magnitude 5.8, so it may be difficult to locate (though it is at least as bright as stars close to it in the sky. To search for Uranus, try <https://lovethenightsky.com/see-uranus-through-a-telescope/>

**Neptune** is magnitude 7.8 and rising around midnight. It's located just on the Pisces side of the border with Aquarius. It has actually gone back into Aquarius before due to retrograde motion but now seems to be in Pisces to stay. In any case, it is located south of the Circler asterism in Pisces. To search for Neptune, try <https://lovethenightsky.com/see-neptune-through-a-telescope/>.

**Pluto** is at opposition at 11:00 p.m. on July 21. There is a locator map on pp. 48-9 of the July 2023 *Sky & Telescope* and online at <https://theskylive.com/where-is-pluto>. Surprisingly, since it tends to stay in the same constellation for decades, Pluto is moving on July 8 from Capricornus into Sagittarius. Since it's also in retrograde motion, it will return to Capricornus next year (and probably back to Sagittarius again in its next retrograde motion—this could go on for a while). However, even though Pluto is still in the near half of its orbit, it doesn't ever get bright enough to see through anything but a large telescope, and in this opposition, it only gets up to magnitude 14.4.

### Viewing Opportunities for Satellites (July 8 – August 12, 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 [skyandtelescope.com/observing/almanac](http://skyandtelescope.com/observing/almanac). You can also get data at <https://spotthestation.nasa.gov/sightings/>.

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

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

Missions to and from the International Space Station and *Tiangong* can change their orbits. The next crewed mission to the ISS will on August 15—however, there is a Cygnus cargo mission scheduled for

August 4. Tiangong recently had a crew change and there are no other missions scheduled for July or August. There will be none to Hubble in the near future. Also note that the ISS (and presumably *Tiangong*) sometimes have to alter orbits to avoid space debris. Hubble is high enough that this is less of a concern.

The information below is from Heavens Above. The Hubble Space Telescope passes usually repeat five or six times with similar trajectories and 10 – 15 minutes earlier each day, to about 30 degrees above the horizon. I quit on August 6 because too much of the viewing opportunities were being lost to Earth's shadow.

ISS 7/10/23 mag. -2.4		
Time	Position	Elevation
10:58 p.m.	251°	10°
11:01	323	39
11:04	34	10

Tiangong 8/1/23 mag. -2.1		
Time	Position	Elevation
5:45 a.m.	288°	10°
5:48	208	56
5:51	130	10

ISS 7/11/23 mag. -3.7		
Time	Position	Elevation
10:08 p.m.	232°	10°
10:11	317	77
10:14	45	10

HST 8/4/23 mag. 1.9		
Time	Position	Elevation
6:10 a.m.	234°	10°
6:13	174	29
6:17	113	10

ISS 7/12/23 mag. -3.6		
Time	Position	Elevation
9:19 p.m.	211°	10°
9:22	135	51
9:25	57	10

HST 8/5/23 mag. -1.8		
Time	Position	Elevation
5:55 a.m.	233°	13°
5:58	175	30
6:02	114	10

Tiangong 7/21/23 mag. -2.1		
Time	Position	Elevation
Appears from Earth's Shadow		
5:19:54 a.m.	231°	26°
5:21:30	152	70
5:25	69	10

Tiangong 8/5/23 mag. -1.8		
Time	Position	Elevation
9:32 p.m.	223°	10°
9:35:05	150	44
9:36:53	86	20
Vanishes into Earth's Shadow		

Tiangong 7/30/23 mag. -2.0		
Time	Position	Elevation
6:07 a.m.	297°	10°
6:10	23	70
6:13	111	10

HST 8/6/23 mag. -1.7		
Time	Position	Elevation
Appears from Earth's Shadow		
5:40:59 a.m.	227°	18°
5:43:13	177	31
5:47	115	10

ISS 7/31/23 mag. -3.8		
Time	Position	Elevation
9:41 p.m.	310°	10°
9:44:37	223	78
9:46:18	141	26
Vanishes into Earth's Shadow		

Tiangong 8/7/23 mag. -2.2		
Time	Position	Elevation
9:09 p.m.	243°	10°
9:12	158	85*
9:15	66	10

\*Passes very close to Vega

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 9:41 p.m. on July 31, measure four fist-widths north of due west (or five west of due north), then one fist-width above the horizon.



## Programming Notice: NASA TV on the Web

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

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

## Calendar of Events

Sometime in 2023: First crewed test launch of *Boeing Starliner-1* to the ISS. (This will almost certainly not happen until 2024).

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

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

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

July 9-10: Mars is in conjunction with Regulus. They are 0.7 degrees apart and to the lower right of Venus, which is also in Leo.

July 12: 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 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 30-31: Peak of Southern Delta Aquariid meteor shower. Moon, alas, will be almost full.

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

August: Launch of India's Aditya-1 heliophysics satellite to the Earth-Sun L1 point (the one between us and the Sun).

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

August 9: Mercury is at greatest eastern elongation, 27.4 degrees from the Sun (so can be seen after sunset).

August 10 (moved from July): 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).

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 a good year since the Moon is a thin crescent.

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

August 15: Crew 7 launch to the ISS by SpaceX. \ \

August 23: Soyuz launch to ISS.

August 27: Saturn is at opposition.

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

September 6: Mercury is in inferior conjunction with the Sun.

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 19: Neptune is at opposition.

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

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

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](http://en.wikipedia.org/wiki/Gilmour_Space_Technologies#Eris).

Fourth quarter of 2023: April Maiden flight of Ariane 6.

Fourth quarter of 2023: 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.

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

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

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

October 19: Mercury is in superior conjunction with the Sun.

October 20: Peak of Orionid meteor shower.

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

November: 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](https://en.wikipedia.org/wiki/Axiom_Space).

November: Sixth crewed flight to the Tiangong space station.

November 2: Jupiter is in opposition to the Sun.

November 5: Peak of South Taurid meteor shower.

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

November 12: Peak of North Taurid meteor shower.

November 13: Uranus is at opposition.

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

November 17: Mars is in conjunction with the Sun.

November 17 – 18: Peak of Leonid meteor shower.

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

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

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

Sometime in 2024: Launch of *Hakuto-R* mission 2, Japan's lunar lander and rover. For more information, see [en.wikipedia.org/wiki/Hakuto](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 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 information, see [https://en.wikipedia.org/wiki/Mars\\_Orbiter\\_Mission\\_2](https://en.wikipedia.org/wiki/Mars_Orbiter_Mission_2).

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

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

Sometime in 2024 (postponed from 2023): UK Pathfinder Launch, from SaxaVord Spaceport on Unst in the Shetland Islands to low Earth orbit. This, amazingly, will be the first orbital launch from the ground in the history of the United Kingdom.

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

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

First quarter of 2024: First (uncrewed) *Gaganyaan* flight test. For more information, see [https://en.wikipedia.org/wiki/Gaganyaan\\_1](https://en.wikipedia.org/wiki/Gaganyaan_1)

February 2024 (tentative): Crew-8 launch to the ISS via Falcon 9.

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

Second quarter of 2024: Second uncrewed *Gaganyaan* test flight.

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

May 2024: Launch of *Chang'e 6*, China's second lunar sample return mission, this time to the Apollo Basin on the far side of the Moon. For More information, see [https://en.wikipedia.org/wiki/Chang%27e\\_6](https://en.wikipedia.org/wiki/Chang%27e_6)

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

Mid-2024: Launch of *Axiom-4 (Ax-4)* mission to the ISS, via Falcon 9. This carries one professional astronaut and three private astronauts, including the winner of the *Space Hero* reality show. For more information, see [https://en.wikipedia.org/wiki/Axiom\\_Space](https://en.wikipedia.org/wiki/Axiom_Space).

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

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

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

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

Fourth quarter of 2024 (moved from 2023): launch of *#dearMoon*, which will carry Japanese billionaire, Yusaku Maezawa, two crew members, and eight artists on a lunar free-return mission. For more information, visit [https://en.wikipedia.org/wiki/DearMoon\\_project](https://en.wikipedia.org/wiki/DearMoon_project).

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

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

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

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

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

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

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

Sometime in 2025: India launches its first crewed orbital flight *Gaganyaan-3*. For more information, <en.wikipedia.org/wiki/Gaganyaan>.

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

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

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

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

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

Sometime in 2025: Launch and landing of Japan/India LUPEX lunar lander. For more information, see [https://en.wikipedia.org/wiki/Lunar\\_Polar\\_Exploration\\_Mission](https://en.wikipedia.org/wiki/Lunar_Polar_Exploration_Mission)

First quarter of 2025: (moved from 2024) Launch of the Mission Robotic Vehicle (MRV) which carries the RSGS (Robotic Servicing of Geosynchronous Satellites) to attach jet packs to remove dying satellites from orbit. For more information, see [https://en.wikipedia.org/wiki/Mission\\_Extension\\_Vehicle](https://en.wikipedia.org/wiki/Mission_Extension_Vehicle).

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

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

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

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

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](en.wikipedia.org/wiki/Artemis_3). (This will likely be postponed to 2026.)

December 2025: *BepiColombo* arrives at Mercury orbit.

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

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. For more information, see [https://en.wikipedia.org/wiki/Chang%27e\\_7](https://en.wikipedia.org/wiki/Chang%27e_7).

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

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

Sometime in 2027: Launch of NEM-1, the core module of the Russian Orbital Service Station. For more information, see [https://en.wikipedia.org/wiki/Russian\\_Orbital\\_Service\\_Station](https://en.wikipedia.org/wiki/Russian_Orbital_Service_Station).

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

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

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

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

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

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

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

First quarter of 2028: Launch of the *Emirates Asteroid Mission* to the asteroid belt, where it will make at least seven flybys of asteroids, the largest of which are Chimaera and Justitia. [See May 2035.]

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

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

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

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

Sometime in 2029 (moved from 2028): Launch of *VERITAS* orbiter and Venus Atmosphere Sample Return Mission to Venus.

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

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

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

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

October 2029: *Juice* achieves Jupiter orbit.

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

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

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

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

Sometime in 2032 [tentative]: Launch of the *Yenisei* lunar flyby mission. This will be the first Russian manned mission to the Moon (though it's not a landing).

Sometime in 2032: Launch of *Artemis 8* to the Moon, which includes the first component of the Artemis Base Camp.

Sometime in 2033: First flight of the Long March 9 super-heavy launch vehicle. This looks like it will be able to carry 53,000 kg to the Moon and 44,000 kg to Mars and will probably carry Chinese astronauts to the Moon.

December 2034: *Juice* achieves Ganymede orbit.

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

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

Sometime in 2036: *Dragonfly* arrives at Titan.

August 12, 2045: The next total solar eclipse visible in Oklahoma City. This one is also visible in Salt Lake City, Denver, Little Rock (again), Tampa Bay and New Orleans.

### **Oklahoma Space Alliance Officers, 2023**

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**Other Information**

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

Science Museum Oklahoma (former Omniplex) website is [www.sciencemuseumok.org](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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