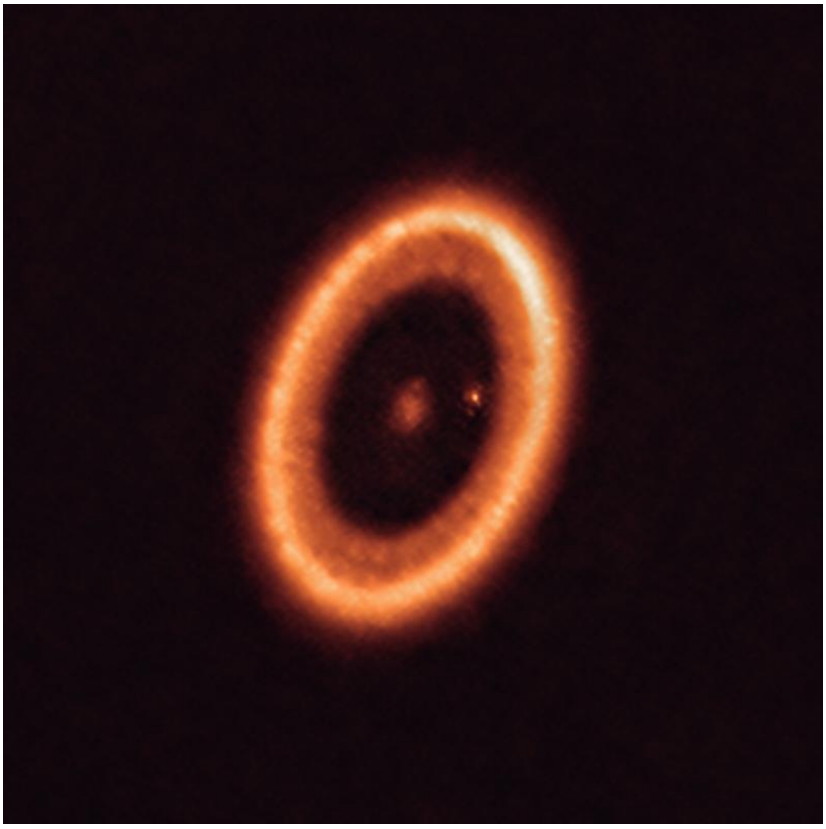
OKLAHOMA SPACE ALLIANCE

OUTREACH -November 2021

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet at the
McMurray residence at 2:00 p.m.
on November 13 details inside



Moon-forming Disk around PDS 70 C (taken by ALMA) (see Page 5)

OKLAHOMA SPACE ALLIANCE OUTREACH
November 2021

November Meeting

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, November 13, at the McMurray's house. Prospective members are welcome. Their house is at 2715 Aspen Circle in Norman. To get to the meeting either: (1) Take the Lindsey Street east exit from I-35, turn right at Berry, and proceed to Imhoff Road. Turn right at Imhoff, right at Poplar Lane, left at Aspen Lane, and right at Aspen Circle. or (2) Take the Highway 9 east off I-35, turn left at Imhoff Road, left at Poplar, left at Aspen Lane, and right at Aspen Circle.

This is the meeting at which we nominate officers. If you wish to serve as an officer of Oklahoma Space Alliance, please let us know at the meeting or contact Syd by e-mail at sydh@ou.edu. Syd will be sending out election ballots around the beginning of December by both e-mail and snail mail. If you wish to be an officer, please contact him by December 1. Note that officers must be members of the National Space Society, though you can join at the Christmas party. Elections will be held at the Christmas Party, tentatively December 11 at the McMurrays'.

We will try to have this meeting on Zoom for those who cannot attend in person: To join the meeting, go to https://tinyurl.com/y2qtab28If for some reason the link doesn't work, contact Dave Sheely at 821-9077 (email sheely at sbcglobal.net) or Syd Henderson at 365-8983 (e-mail sydh at ou.edu) and we will send you updated information.

Saturday November 13, 2021, 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/Update2111.pdf for items to be discussed
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
   a. Review OSA treasurer's report
   b. Minutes of October meeting
   c. Nomination of Officers
   d. Christmas party
   e. Chapters Assembly (Syd)
5. Video (to be announced)
6. Chat

Minutes of October 2021 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance met October 9 at the McMurray's house. Attending in person were Adam Hemphill, Claire and Clifford McMurray. Dave Sheely, and Syd Henderson. Robin Scott attended by Zoom. After a late start, OSA President Dave Sheely presided over the meeting. He did an Update discussing links to material covered in the meeting and this is online at http://osa.nss.org/Update2110.pdf so I'll cover the details that aren't covered there.

We watched a video presenting the new uniforms for Space Force. The unforms are compared to Star Trek (particularly Saavik in *The Wrath of Khan*) and a bellhop. The buttons use the Space Force emblem,

We watched a video of the highlights and splashdown of *Inspiration 4*.

We watched a video of Northrup-Grumman's mission extension satellite that is designed to add propulsion units to satellites that are dying for lack of fuel.

We watched a video from Mars rover *Perseverance* showing *Ingenuity* flying at 8 meters height.

We watched a video "Creating the First Gas Station in Space." Orbit Fab is launching propellant depots into space. Previously, Orbit Fab was the first company to supply water to the ISS.

Minutes by OSA Secretary Syd Henderson

Minutes of September 2021 Oklahoma Space Alliance Meeting

Oklahoma Space Alliance chapter of National Space Society had its regularly scheduled meeting on September 11, 2021, at the McMurray residence in Norman, Oklahoma. Attending were David Sheely, Clifford and Claire McMurray, John Northcutt, Tim Scott, and Syd Henderson. OSA president Dave Sheely presided over the meeting. He did an Update discussing links to material covered in the meeting and this is online at http://osa.nss.org/Update2109.pdf/ so I'll cover the details that aren't covered there.

We watched a CNBC video in which their NASA watchdog said that spacesuit issues will delay the 2024 Moon landing.

We watched a Space.com interview with *Inspiration4* astronauts Sian Proctor and Christopher Sembroski.

We watched a video on spacesuit technology by Project Ianus. Among other things it contains what amounts to an adult-sized diaper.

We watch a video of the technology behind the Tiangong space station.

We watched a video of the Firefly Alpha explosion. The video shows the rocket moving sideways.

We watched a video about the Unity 22 straying from its flight path that led to a temporary suspension of Virgin Galactic manned missions.

We watched a video of the Virgin Orbit launch.

We watched a video of NASA Administrator Bill Nelson's address to a Space Symposium. NASA is launching a new app placing space mapping data into the hands of farmers. The address ended with videos on the Artemis project.

Minutes by OSA Secretary Syd Henderson

Vote from Chapter Assembly

Via Dennis Pearson:

The National Space Society Chapter Assembly met November 6, 2021, in a Saturday Sessions and discussed the – 49th Anniversary Apollo 17 Countdown to the 50th Anniversary.

1) Joe Bland received an Email from Chris Nobbe about holding a 49th Anniversary Apollo 17 Party as Countdown to the 50th Anniversary ... She had previously contacted the NSS Chapter Assembly about her plans.
2) Chris Nobble announced she wants to do a traditional St Louis Frontier Gateway to Space program associated or in partnership with the Sacramento L5's Breakfast on the Moon concept in celebrating the 49th Anniversary of the Apollo 17 Moon Landing. This Party or Zoom meeting with speakers would be a Countdown to the 50th Anniversary of Apollo 17 Moon landing next year.
3) This event will be held on Saturday Morning December 11 at 7:00 AM PT .. And the idea by Dennis Pearson of having a clock counting down to the Apollo 17 50th Anniversary will be pursued on the Sacramento L5 Web site, and it is encouraged for sites.
4) Jeff Liss Made the following motion and Dennis Pearson seconded it: "Support a Gateway to Space/ Breakfast on the Moon event to commemorate the 49th anniversary of Apollo 17."
5) Voting yes - David Cawood: DC L 5, Avinash, India, David Stuart, Seattle, Christine Nobbe, St. Louis, Mario Anzalotti, Phoenix, Michael Stennecken, German Space Society; Dennis L. Pearson: PASA, Jan Roston Sacramento, George Cooper: CVSS; Jeffry Liss, North Shore; Chris Cerone, Oasis; Bennet Rutledge, Denver
6) Bennett Rutledge declared the motion to have passed unanimously but the polls will remain open for two weeks to allow other Chapters who have not attended this meeting to cast a vote.

If the voting representative of your Chapter did not attend this meeting, you have until November 20, 2021, to reply to this email with a yes or no vote to the following motion: Support a Gateway to Space/ Breakfast on the Moon event to commemorate the 49th anniversary of Apollo 17."

Space News

At 9:33 p.m. (CST) on November 8, SpaceX Crew-2 returned to Earth after 200 days, bringing back Shane Kimbrough, Megan McArthur, Akihiho Hoshide and Thomas Pesquet from the ISS.

Crew-2 was supposed to return after the arrival of SpaceX Crew-3, but that launch has been delayed several times because of weather and health concerns over one of the astronauts. It is now scheduled to launch on the evening of November 10.

A team of astronomers, led by Rosanne Di Stefano (Center for Astrophysics, Harvard & Smithsonian) appear to have detected what is the first known exoplanet outside of our galaxy. (The term coined is extroplanet). If it's real, it is also the weirdest, since it orbits a system where some object, either a black hole or a neutron star, is gobbling up matter in the form of an accretion disk of matter from a companion black hole. This disk gets very hot, emitting X-rays as matter is consumed, but the X-rays come from a very small region around the object—small enough that something, probably a planet, was able to block the X-rays for several hours. The blocking object is too small to be a non-M type star and can't be a white dwarf or other massive object or it would have produced a gravitational lensing effect. It's still possible it could be brown dwarf or very small red, but there's a very good chance it is smaller that Jupiter. If it is a planet, there is almost no chance it could have life because, well, X-rays.

November 8, Astronomers discovered a disk around the exoplanet PDS 70c. The disk looks big enough to form three moons. The discovery was maid by the Atacama Large Millimeter/Submillimeter Array (ALMA) in northern Chile. The main star, PDS 70 (or V1032 Centauri), has a protoplanetary disk so will eventually have more than the two newborn exoplanets already discovered.

The *Lucy* spacecraft was launched by the United Launch Alliance at 5:34 EDT on October 16, beginning a twelve-year mission that will take it to both of Jupiter's Trojan asteroid belts, where it will fly by at least six Trojan asteroids and a main belt asteroid to boot. The most prominent is 617 Patroclus, a Greek spy in the Trojan camp, and its companion Menoetius, which are about 70 and 62 miles in diameter, but we won't see those until 2033. If the spacecraft has fuel to maneuver, we'll undoubtedly see a bunch more in the trailing Trojan Camp at the Sun-Jupiter L_5point. The other four planned Trojan flybys are in the lead (L_4) Greek camp.

The main Belt asteroid is 52246 Donaldjohanson, named after the discoverer of the hominin fossil Lucy which in turn was named after the song "Lucy in the Sky with Diamonds." The asteroid was named in December 2015 although it was discovered in 1981. It is only about 2.4 miles in diameter, so I suspect it got its name after *Lucy*'s target was decided.

The Hubble Space Telescope had a glitch last month that put all five of its instruments into safe mode. The first of these, the Advanced Camera for Surveys, came back online on November 7. NASA hopes to bring the other four instruments online in the next few weeks.

Elemental differences in a globular cluster orbiting the Large Magellanic Cloud reveals that the LMC swallowed a dwarf galaxy billions of years ago. Since the LMC will eventually be swallowed by the Milky Way, I'm reminded of those pictures of tiny fishes being swallowed by little fishes being swallowed by medium sized fishes, etc. Thus, the Milky Way is not only a cannibal galaxy, it eats cannibal galaxies.

Sky Viewing

The next two months feature two eclipses (one of which we can actually see) and the year's last major meteor shower as well as four three easily visible planets (not counting Earth) and three which are not.

The not-visible eclipse is the **total eclipse of the Sun** on December 4, which begins in the far south Atlantic northeast of the Antarctic Peninsula, crosses the Weddell Sea (and the South Orkneys), crosses West Antarctica south of the Peninsula, and ends up in the ocean west of the peninsula. (Technically, the water crossed is the Southern (or Antarctic) Ocean. I suspect the only people to see totality are the 50-odd people on the South Orkneys and anyone taking an Antarctic cruise, not to mention millions of penguins.

Far more accessible is the November 19 **partial lunar eclipse**. Unlike most partial lunar eclipse, this one should be worth watching since totality is 97%. This eclipse will be visible through all North America, with the Atlantic coast missing part of the passage through the Earth's penumbra, and that part isn't all that visible anyway. The eclipse will begin around 1:19 a.m. CST and end at 4:47 a.m., with the peak at 3:00 p.m. The illuminated crescent will be only a thousandth as bright as the Full Moon, or the same magnitude as Venus. But not appearing as bright because Venus is pretty much a point source, and the crescent is not.

Incidentally, this is apparently the longest lunar eclipse of the century partly because the Moon is near apogee and fits (mostly) comfortably in the Earth's shadow. But it's obviously not the one with longest totality.

There are several minor meteors shows in November and December, including the Northern Taurids peaking on November 12, and the Puppid-Velids in early December (which are also far south). The **Leonids**, which peak on November 17, can be spectacular in a good year, which 2022 is expected to be, but this year is not, with only 10 – 15 meteors per hour. To make it worse, the Full Moon is November 19, and will drown them out. Similarly, the **Ursids**, which also produce about 10 an hour, occur during a gibbous moon.

So do the **Geminids**, but they are generally the most prolific meteor shower (assuming the Leonids are not having a special year), and their radiant is close to Castor, the less bright of the Heavenly Twins, which is high in the sky at night. The best time to look is 3:00 a.m. or later, when the Moon is out of the sky.

Mercury is currently lost in the Sun's glow at dawn and is heading toward a superior conjunction with the Sun on November 28, so we won't be seeing it until the second half of December. The best time to look is December 26 – 30, when Mercury will be less than ten degrees from unmissable Venus and magnitude -0.8 in its own right. Look in the western sky about 45 minutes after sunset.

Venus is about at its peak brightness right now, and high in the southwestern sky when twilight fades. Amazingly, it actually increases in brightness from magnitude -4.7 now to -4.9 on December 4. It's in Sagittarius but moves toward (but doesn't quite reach) Capricornus in mid-December, when it provides a guide to the much dimmer **Comet Leonard** about five degrees below. Comet Leonard may reach naked-eye visibility, but binoculars should find it easily.

Mars, on the other hand, is near minimum brightness, but is still magnitude 1.6. A bigger problem is it is with Mercury in the morning twilight and Mercury is brighter. Mars will separate from the Sun in December, rising two hours earlier than the Sun by Christmas, and will be less than five degrees north of Antares. Since Mars will still be about magnitude 1.6, Antares will be half a magnitude brighter.

Jupiter is shining bright in the south at sunset and is up until midnight. At magnitude -2.4, it's not quite as bright as it was at opposition but is close. Jupiter is in the eastern part of Capricornus but will move into Aquarius in mid-December. It was in Aquarius briefly earlier in the year before retrograde motion took it back into Capricornus.

Saturn, meanwhile, is magnitude 0.6, also not as bright as it was a couple of months ago but still easy to find since it's first magnitude and on the ecliptic between Venus and Jupiter. Since Saturn is at the western end of Capricornus, this gives you the boundaries of that inconspicuous constellation. Saturn is

currently setting about 10:30 p.m. and will set at 9:00 at the end of November and about 7:00 at the end of December.

Since Venus and Saturn are in the same area of the sky you may wonder if there's a conjunction coming up. There is, but not right now. They get 16 degrees apart in mid-December, then separate. But they come together again next spring, and on the morning of March 29, will be two degrees apart. More spectacular will be the conjunction of Venus and Jupiter on the morning of April 30 when they are separated by only 14 arcminutes—that is, half the diameter of the Moon.

Incidentally, **Uranus**, **Neptune** and **Pluto** are also in the evening sky. Uranus is up in the east by 7:00 p.m. in the southern part of Aries, and Neptune is nearing the border between Aquarius and Pisces and high in the southeast at sunset. Uranus is just visible to the naked eye in very dark sky, while Neptune probably requires a small telescope. Pluto, which requires a LARGE telescope, is near the ecliptic about two-thirds of the way to Saturn from Venus, despite both Pluto and Venus being is Sagittarius. For the record Pluto and Venus have a conjunction on December 11 and again on March 5, in a period when Mars, Venus and Pluto are having a series of conjunctions.

Uranus, incidentally, is just past opposition and actually potentially locatable since it's not far from the sixth magnitude omicron Arietis, which is part of a dim but striking Y-shape pattern which includes delta Arietis which is magnitude 4.35 and actually has a name (Botein). This gives *Sky and Telescope* the opportunity to show a star map, and here you are: https://skyandtelescope.org/astronomy-blogs/explore-night-bob-king/uranus-queues-up-for-opposition/.

Viewing Opportunities for Satellites (November 13 – December 13, 2021)

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

With the addition of the solar panels, the International Space Station can be as bright as magnitude -4.0 making it brighter than all the stars other than the Sun and all the planets other than Venus, although magnitude -2 to -3 is more likely. The Hubble Space Telescope can get up to magnitude 1.5, which is brighter than the stars in the Big Dipper. *Tiangong* is the Chinese Space Station. It currently gets up to magnitude 1.0 but will get brighter as more modules are added. 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 can change its orbit, and the ISS is active this month. The Crew-2 mission left the ISS on November 8, The Crew-3 mission is delayed, and as of this writing will launch on the morning November 10 (the day after this newsletter is sent out). This mission was supposed to launch on October 31 but was delayed by weather and a minor health issue with a crew member. Later launches include a Soviet module on November 24 and a Soyuz crewed mission on December 8.

The Tiangong 3 space station's second crew was launched on October 15 and will return in April. I'm sure there will be some resupply missions before then, but I have no dates.

The NASA website that I was using for sightings information has been retired as of February 25, 2021. The information below is from Heavens Above.

Tiangong 11/14/2021 mag. 1.6

Time	Position	Elevation
Appears from Earth's shadow		
5:46 a.m.	222°	24°
5:48	152	57
5:51	72	10

Tiangong 11/15/2021 mag. 1.5

Time	Position	Elevation
6:23 a.m.	267°	11°
6:26	342	46
6:29	109	10

ISS 18 November 2021 mag. -3.6

Time	Position	Elevation
6:19 p.m.	213°	10°
6:22:37	135	56
6:24:30	64	23

Vanishes into Earth's shadow

Tiangong 11/23/2021 mag. 1.1

Time	Position	Elevation
6:41 a.m.	297°	10°
6:44	23	74
6:47	109	10

Tiangong 11/25/2021 mag.1.4

Time	Position	Elevation
6:22 a.m.	284°	17°
6:25	209	55
6:28	130	10

HST 27 November 2021 mag. 2.2

Time	Position	Elevation
6:44 a.m.	246°	10°
6:47	183	31
6:51	120	10

HST 28 November 2021 mag. 2.2

Time	Position	Elevation
6:33 a.m.	247°	10°
6:36	185	30
6:40	123	10

HST 29 November 2021 mag. 2.3

Time	Position	Elevation
6:21 a.m.	247°	10°
6:25	187	28
6:29	127	10

Tiangong 11/28/2021 mag. 1.0

Time	Position	Elevation
6:32 p.m.	243°	10°
6:25:31	156	88
6:36:39	69	40

Vanishes into Earth's shadow

ISS 8 December 2021 mag. -2.7

Time	Position	Elevation
6:36 p.m.	301°	10°
6:39	226	46
6:42	152	10

ISS 9 December 2021 mag. -3.8

Time	Position	Elevation
5:48 p.m.	313°	10°
5:51	39	88
5:54	133	10

Tiangong 12/10/2021 mag. 1.6

Time	Position	Elevation
6:15 p.m.	261°	10°
6:19	340	52
6:21	51	26

Vanishes into Earth's shadow

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. Thus, to find the Tiangong Space Station at 6:25 a.m. on November 25, look just under three fist-widths west of due south, then a five and a half fist-widths up from 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.

November 10, 3:45 p.m.: Launch coverage begins for SpaceX's Crew-3 mission. Launch is at 8:03 p.m., with docking tomorrow at 6:10 p.m.

November 15, time to be determined: Deep Space Food Challenge.

November 30: ISS Space Walk coverage, time to be determined. This will last 6 ½ hours.

The James Webb Space Telescope is scheduled to launch at 6:10 a.m. on December 18 from Kourou, French Guiana, and NASA-TV will certainly be covering that and probably some later actions as the telescope unfurls and heads toward the Earth-Sun L-2 point.

I don't see DART (the Double Asteroid Redirection Test) November 24 launch on their schedule, and the Imaging X-Ray Polarimetry Explorer on December 9 is beyond their current schedule.

Calendar of Events

November 12: Peak of North Taurid meteor shower.

November 13: Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

November 17: Peak of Leonid meteor shower (unfortunately coinciding with the Full Moon.

November 19: Partial lunar eclipse, 3:02 a.m. peak, visible from Oklahoma. Since the moon is 97% covered, this is not far from being a total lunar eclipse.

November 24, 12:20 a.m.: Launch of DART, the Double Asteroid Redirection Test to 65803 Didymos (which is the double asteroid). For more information, see https://en.wikipedia.org/wiki/Double_Asteroid_Redirection_Test. \ November 24, 7:06 a.m.: Soyuz launch of Prichal module to the ISS. For more information, see https://en.wikipedia.org/wiki/Prichal_(ISS_module).

November 28: Mercury is in superior conjunction with the Sun.

December: First flight of India's SSLV Small Satellite Launch Vehicle.

December 4: Total eclipse of the Sun. Unfortunately, this one is only visible from West Antarctica and the ocean around it.

December 8: Soyuz crew mission to the ISS from Baikonur. This includes one professional cosmonaut and two tourists.

December 9, midnight: launch of Imaging X-Ray Polarimetry Explorer by SpaceX. For more information, see https://en.wikipedia.org/wiki/IXPE.

December 11 [Tentative]Oklahoma Space Alliance Christmas Party and elections, McMurray residence

December 14: Peak of the Geminid meteor shower.

December 22: Peak of Ursid meteor shower.

First half of 2022: Orbital test flight of Boeing Starliner to the ISS.

Early 2022 [moved from October 2021]: The first Nova-C mission will carry the IM-1 lander and Moon Mark and Spacebit lunar rovers to the Moon between Mare Serenitatis and Mare Crisium. To be launched by SpaceX.

First quarter of 2022: Second launch attempt of Firefly Alpha.

January 2022: [Moved from December 2021]: SpaceX will launch a whole bunch of small satellites on one launch, including two Sherpa space tugs, two cubesat dispensers, and a bunch of Earth observation satellites.

January 3, 2022: Peak of Quadrantid meteor shower.

January 7, 2022: Mercury is a greatest eastern elongation, 19.2 degrees from the Sun (hence can be seen after sunset).

January 8, 2022 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

January 8, 2022: Venus is in inferior conjunction with the Sun.

January 23, 2022: Mercury is in inferior conjunction with the Sun.

February12, 2022 [Moved from December]: Earliest launch date for *Artemis 1* the first launch of the Space Launch System. On this launch NASA launches the Lunar IceCube, Lunar Polar Hydrogen Mapper, and Lunar Flashlight lunar orbiters, in addition to Japan's OMOTENASHI cubesat lunar lander. For more information, see https://en.wikipedia.org/wiki/Lunar_IceCube, the Near-earth Asteroid Scout cubesat (https://en.wikipedia.org/wiki/Near-Earth_Asteroid_Scout)and a bunch of other satellites.

February 4, 2022: Saturn is in conjunction with the Sun.

February 12, 2022 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

February 21, 2022: Launch of *Axiom Space Mission 1* which will carry a commercial crew of four to the ISS via SpaceX Crew Dragon. For more information, see https://en.wikipedia.org/wiki/Axiom_Mission_1.

March 5, 2022: Jupiter is in conjunction with the Sun.

March 12, 2022 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

March 20. 2022: Venus is at greatest western elongation, 46.6 degrees from the Sun (hence can be seen before sunrise).

Second Quarter of 2022 [Moved from late 2021.]: 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

Mid 2022: [Moved several times]: Maiden flight of the Vulcan Centaur, ULA's new heavy launch vehicle. which will carry the Peregrine lunar lander. For more information, visit https://en.wikipedia.org/wiki/Vulcan_(rocket) and https://en.wikipedia.org/wiki/Astrobotic_Technology#Peregrine_lander.

April 9, 2022 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

April 15, 2022: Launch of SpaceX Crew-4 mission to the ISS.

April 16 – 27, 2022: 50th anniversary of Apollo 16.

May 2022: Third crew to the Chinese Space Station. Also launch of Wentian, the first lab module to the station.

May 14, 2022 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

May 19, 2022: Second flight of South Korea's *Nuri*, and the first with a commercial payload.

June 2022: First test flight of Gaganyaan, which will eventually become India's first manned spacecraft. For more information, see https://en.wikipedia.org/wiki/Gaganyaan.

June 2022 [Moved from March]: Launch of *Eris*, the first Australian rocket to launch an Australian payload. *Eris* is the launch vehicle for Gilmour Space.

June 11, 2022 [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., McMurray residence

Second half of 2022: Launch of ALINA (the Autonomous Landing and Navigation Module) near the *Apollo 17* landing site. This will land two rovers which will search for Apollo 17's lunar rover.

Third quarter of 2022 [moved from January]: India launches Aditya-L1 to the Earth-Sun L1 point, on a mission to study the Sun's corona. For more information, visit https://en.wikipedia.org/wiki/Aditya-L1.

July 2022 [Moved from May 2022]: Launch of the Luna 25 lunar lander, the first mission of Russia's Luna-Glob lunar exploration mission. For more information, visit en.wikipedia.org/wiki/Luna_25 and en.wikipedia.org/wiki/Luna-Glob.

August 2022: Launch of Psyche, which will orbit a large metallic asteroid also named Psyche. For more information, visit https://en.wikipedia.org/wiki/Psyche_(spacecraft).

August 2022: Launch of Mengtian, the second laboratory module to the Tiangong space station.

August 1, 2022 (postponed from December 2020]: Launch of the Korea Pathfinder Lunar Orbiter (KPLO) and lunar impactor from Naro Space Center in South Korea. For more information, see https://en.wikipedia.org/wiki/Korea_Pathfinder_Lunar_Orbiter.

August 26, 2022: [Moved from March] Launch of JUICE, the Jupiter Icy Moons Explorer, by the European Space Agency. The JUICE web site is https://sci.esa.int/web/juice .

September 2022: First UK Pathfinder launch from SaxaVord in the Shetland Islands (probably). Amazingly, this appears to be the first orbital launch from the United Kingdom.

September 20, 2022 [postponed from 2020]: ESA launches the ExoMars Mars Rover, which has been christened Rosalind Franklin, and the Exomars 2020 surface platform. For more information, visit https://en.wikipedia.org/wiki/ExoMars.

Fourth quarter of 2022: First flight of Blue Origin's *New Glenn* orbital rocket. For more information, see https://en.wikipedia.org/wiki/New_Glenn.

Fourth quarter of 2022 [Moved from 2020.] 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.

Fourth quarter of 2022: Launch of Axiom-2 mission to the ISS, via Falcon 9. This carries one professional astronaut and three private astronauts.

October 2022: Launch of *Hakuto-R* mission 1, Japan's lunar lander. (Hakuto is Japan's Moon rabbit, so is equivalent to China's Jade Rabbit). For more information, see https://en.wikipedia.org/wiki/Hakuto.

November 2022: Launch of fourth crew to the Tiangong space station.

December 2022: Launch via Falcon 9 of the *Nova-C* lander and other cargos to the Lunar South Pole.

December 7 – 19, 2022: 50th anniversary of Apollo 17. This, to date, is the last manned mission to the Moon.

Sometime in 2023: India launches its first manned orbital flight *Gaganyaan-3*.

Sometime in 2023 (Really, really tentative): launch of #dearMoon, which will carry six to eight artists on a lunar free-return mission.

Sometime in 2023: Rocket Lab launches an atmospheric probe and flyby to Venus.

First quarter of 2023: First Dream Chaser cargo mission.

March 2023: First crewed launch of Boeing Starliner-1 to the ISS. Note: I had this down for April 2022, but due to recurring valve problems with the Starliner test vehicle, it keeps getting pushed.

April – July 2023: The ExoMars Mars landers land on Mars. This includes the Russian Kazachok surface platform and the ESA's Rosalind Franklin Mars rover.

Mid 2023: First launch of Firefly's *Blue Ghost* lunar lander.

June 2023 [approximate, moved from 2022]: First crewed launch of an Orion space capsule.

September 2023: 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.

September 24, 2023: OSIRIS-REx returns samples from Asteroid Bennu.

Fourth quarter of 2023: Launch of Hakuto-R mission 2, Japan's lunar lander and rover. For more information, see https://en.wikipedia.org/wiki/Hakuto.

November 2023: Launch of NASA's VIPER lunar rover, which will hunt for ice near the at Nobile Crater at Moon's South Pole. VIPER is landing aboard Astrobotic's *Griffin* lunar lander.

November 2023: Launch of Masten Mission One lander and MoonRanger rover on the Moon via Falcon 9.

December 15, 2023: uncrewed test launch of *Orel*, Russia's new crewed spacecraft. For information, https://en.wikipedia.org/wiki/Orel_(spacecraft).

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

First half of 2024: Israel launches its *Beresheet 2* lander and orbiter on the Moon.

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: Commercial Lunar Payload Services mission delivers a lunar lander in Schrödinger Basin,

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

October 2024: Planned date of Artemis 3, which will land astronauts on the Moon for the first time since 1972.

October 2024: Launch of *Europa Clipper* orbiter. For more information, https://en.wikipedia.org/wiki/Europa_Clipper,

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

December 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 [moved from 2024]: India launches its Mangalayaan–2 Mars mission, which includes an orbiter, lander, and rover.

Sometime in 2025: 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.

September 2025: First crewed flight of Russia's Orel (formerly called Federatsiya).

December 2025: 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.

December 2025: BepiColombo arrives at Mercury orbit.

January 31, 2026: The Psyche asteroid probe arrives at the asteroid 16 Psyche. For more information, visit https://en.wikipedia.org/wiki/Psyche_(spacecraft).

July 2026: Launch of the Sample Retrieval Lander to Mars. This is the lander which will bring take the samples taken by *Perseverance* to orbit.

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

October 2026: 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: Launch of *VERITAS* to Venus.

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

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

Fourth quarter of 2029: Launch of *DAVINCI+* to Venus.

October 2029: JUICE achieves Jupiter orbit. [See 2022.]

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, 2021

Dave Sheely, President &Update Editor	405-821-9077 (C)
Clifford McMurray, Vice- President	405-329-4326 (H) 405-863-6173 (C)
Syd Henderson, Secretary & Outreach Editor	405-321-4027 (H) 405-365-8983 (C)
Tim Scott, Treasurer	405-740-7549 (H)

OSA E-mail Addresses and Web Site:

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

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

Other Information

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

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

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

The Mars Society address is Mars Society, Box 273, Indian Hills CO 80454. Their web address is www.marsociety.org.

The National Space Society's Headquarters phone is 202-424-2899 (new as of May 2019). Executive Director e-mail nsshq@nss.org. The Chapters Coordinator is Bennett Rutledge 720-641-7987, rutledges@chapters.nss.org. The address is: National Space Society, PO Box 98106, Washington DC 20090-1600 Web page is space.nss.org.

The Planetary Society phone 626-793-5100. The address is 65 North Catalina, Avenue, Pasadena, California, 91106-2301 and the website is www.planetary.org. E-mail is tps@planetary.org.

NASA Spacelink BBS 205-895-0028. Or try www.nasa.gov. .

Congressional Switchboard 202/224-3121.

Write to any U. S. Senator or Representative at [name]/ Washington DC, 20510 (Senate) or 20515 [House]

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

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

_____ TOTAL amount enclosed

National Space Society has a special $20 introductory rate for new members. Regular membership rates are $52, Student memberships are $36, Senior $42. Part of the cost is for the magazine, *Ad Astra*. If you choose to receive the magazine digitally, memberships are $40 for regular, $24 for students and $30 for seniors. Mail to: National Space Society, PO Box 98106, Washington, DC 20090, or join at www.nss.org/membership**.** (Brochures are at the bottom with the special rate.) Be sure to ask them to credit your membership to Oklahoma Space Alliance.

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

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

Name_____

Address_____

City_____ State___ ZIP_____

Phone (optional or if on phone tree)_____

E-mail address (optional)_____

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