OKLAHOMA SPACE ALLIANCE

OUTREACH –May 2020

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance meeting
For May 2020 has been cancelled.
See you in June!

Figure 1 Robert Behnken and Douglas Hurley, the crew of NASA'S First Commercial Crew Mission to the International Space Station (credits: NASA)

OKLAHOMA SPACE ALLIANCE OUTREACH
May 2020

May Meeting Cancelled; June Plans

Oklahoma Space Alliance will not meet in May due to the continuing COVID-19 pandemic and several of our members being in high-risk categories.

Current plans are to meet at 2:00 p.m. on Saturday, June 13 at Claire and Clifford McMurray's house. Prospective members are also welcome. Their house is at 2715 Aspen Circle in Norman.

To get to the June 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. The turns at Poplar, Aspen Lane and Aspen Circle are the first you can take, 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. To verity that the meeting is occurring, call Syd Henderson at 365-8983 or Clifford McMurray at 863-6173 or e-mail sydh at ou.edu.

Saturday June 13, 2020 2:00 p.m. (tentative)
Place: McMurray Residence

1. Introductions and review of Space events this past month
2. What's Happening in Space, News, Pictures, and Videos approximately one hour
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
   a. Review OSA treasurer's report
   b. Minutes of February Meeting
   c. Future Activities (Space week?)
5. Video (to be announced)
6. Chat

Minutes

The March and April meetings were also cancelled because of the coronavirus and shelter in place, so there are no minutes for those months. However, Kip did do Updates for those months, and they are online at http://osa.nss.org/Update2003.pdf and http://osa.nss.org/Update2004.pdf so you can keep up with recent space news. The April one has lots of articles on the current Moon initiative.

Space News

[Cover story] If all goes as planned, May 27 marks the return of American manned launches into orbit after a hiatus of nearly nine years, during which all manned orbital launches were either by Russia via Baikonur Cosmodrome in Kazakhstan, or by China. It will also mark the first orbital manned launch by a commercial spacecraft. [There have of course been suborbital manned launches by American companies, notably those aboard SpaceShipOne, and any number of orbital unmanned launches by commercial space companies.]

At 3:32 p.m. CDT on Wednesday, May 27, SpaceX will launch its Demo-2 test flight of its Crew Dragon spacecraft to the International Space Station. This time it will carry two astronauts, Robert Behnken and Douglas Hurley on its first manned flight, and the first Commercial Crew mission to carry astronauts to the ISS. It will also be the first American spacecraft to carry humans into orbit since the last Space Shuttle launch, that of *Atlantis* on July 8, 2011. That carried only four astronauts to orbit, the fewest of any shuttle since 1983. The two-person crew of Demo-2 is the smallest of any American orbital spacecraft since STS-4 back in 1982.

Robert Behnken is 49 years old and is a Colonel in the Air Force as well as holding a degree in mechanical engineering. He previously flew on two Shuttle missions, in 2008 and 2010 and was Chief of the Astronauts for three years starting in 2015. His wife is astronaut K. Megan McArthur, who was the first astronaut to touch the Hubble Space Telescope (using the robotic arm).

Douglas Hurley is 53 years old and is an engineer as well as the pilot of shuttle missions in 2009 and 2011. The latter mission was final Shuttle flight, so he represents both ends of the American orbital space hiatus. His wife is former astronaut Karen Nyberg. NASA-TV will be providing continuous coverage of the first commercial crew mission from four hours before launch through the welcoming ceremony at the ISS.

Because of the ongoing COVID-19 pandemic, most media presentations will be remote except for a few selected personnel. It's worth noting that the astronauts would be quarantined for several weeks before launch to keep them to make sure neither of them will bring the plague into space.

Behnken and Hurley will remain onboard the ISS for up to four months. The length of their stay depends on how long it will take SpaceX to send up their replacements.

COVID-19 also means changes in mission control, with desks having to be six feet apart (and a lot will probably be done remotely).

NASA has selected the three companies to build human landing systems for the Artemis program. They are Blue Origin and SpaceX (no surprise there), and Dynetics, a Huntsville, Alabama based company that I'm not familiar with. The last's Dynetics Human Landing System (DHLS) will launch on the United Launch Alliance's Vulcan launch system. Blue Origin's Integrated Launch Vehicle (ILV) can launch either on the Vulcan or the company's own New Glenn rocket. SpaceX's lander is Starship, which will be launched by its Super Heavy rocket.

Mars 2020's robot helicopter now has a name: *Ingenuity*. Alabama high school student Vaneeza Rupani originally submitted the name for the Mars 2020's rover, but it lost out to *Perseverance*. Apparently, NASA decided the helicopter needed a better name than Mars helicopter (or maybe they read the March *Outreach*).

Ingenuity only has a mass of 1.8 kilograms and carries no scientific instruments. It is intended as a technology demonstration to show that it is indeed possible to fly a helicopter on Mars. Thus, it is a prelude not only for future helicopters on Mars, but also the *Dragonfly* robocraft destined for Titan.

In her essay for the rover contest, Rupani wrote "The ingenuity and brilliance of people working hard to overcome the challenges of interplanetary travel are what allow us all to experience the wonders of space exploration. Ingenuity is what allows people to accomplish amazing things, and it allows us to expand our horizons to the edges of the universe."

Space-Related Articles

"Space Dust: How an Asteroid Altered Life on Earth…Millions of Years Before the Dinosaurs," by Richard A. Lovett, *Analog*, May/June 2020, pp.70 – 77. 466 million ago a mighty collision in the asteroid belt scattered debris throughout the inner solar system and the debris is still falling. From the effect on the fragments of the asteroids that have survived, the kinetic energy of the collision is known, and it's figured that the smaller was twenty kilometers (12 miles) across and the larger was 150 kilometers (ninety miles) in diameter. No larger collision has taken place since then. The fragments include some 13,000 asteroids, including 8 Flora, and you can tell how large that is by its being the eighth discovered asteroid. The debris is easily recognized because the larger asteroid was a type called a L-chondrite, the "L" signifying that they are low in iron. The date is set by the ratio of argon to potassium-40. (A collision like this releases all the argon contained in the rocks.)

But another indication of the date is that 466 million years ago the Earth experienced the Mid-Ordovician ice age and a lot of the debris from the collision was trapped in the rocks as the sea dropped. According to a new theory, the collision put so much dust inside the Earth's orbit that it cooled the Earth by blocking sunlight. You might expect that this would produce a mass extinction, but it fact the cooling occurred so gradually that organisms were able to adapt and the exact opposite happened: it caused what is known as the Great-Ordovician Biodiversity Event.

The author then speculates that perhaps we might want to put a small asteroid at the Earth-Sun L-1 point and periodically blow off some dust to reverse the greenhouse effect of carbon emission. [How could this possibly go wrong? 😊]

Sky Viewing

We had a brief flurry of hope when it appeared a bright comet might grace our sky this year, but, alas, Comet ATLAS is disintegrating on its way to the Sun. But we will have a naked-eye comet (we hope) this month as Comet SWAN will reach magnitude 3.5 during the week of May 15 – 23. It's located low in the sky, moving from Triangulum to Perseus. Magnitude 3.5 is not terrific for a diffuse object like a comet, but it should be easy to locate with binoculars and a little harder with the naked eye.

Mercury was in superior conjunction with the Sun on May 4, hence is currently lost in the Solar glare. However, it will become visible in the evenings in late May, and will be in conjunction with **Venus** on May 21, when they will be separated by less than a degree. At this point, they will be about eight degrees above the horizon about an hour after sunset. Venus will be magnitude -4.4 and Mercury at magnitude -0.6, so they should be easy to find if you have a clear horizon. Mercury will be the only visible planet in the sky at sunset in June, setting and hour and forty-five minutes after the Sun during the first week in June. However, Mercury will fade rapidly after that as it approaches inferior conjunction on July 1.

Venus is the bright planet in the western sky at sunset, shining at magnitude -4.7. It's getting lower in the sky and will be only eleven degrees above the horizon an hour after sunset on May 16. After that, it will rapidly disappear as it approaches inferior conjunction on June 3. Since this is an inferior conjunction, Venus will brighten quickly afterward, rising 45 minutes before the Sun on June 12, 80 minutes on June 20, and by June 30 will be rising a full two house before the Sun, by which time it will be back to its flamboyant magnitude -4.7.

The outer visible planets are all morning stars at the moment. **Jupiter** is currently rising about 2:00 a.m., and by the end of May will be rising at midnight. At -2.4, it is the brightest object in the morning night sky unless the Moon is up. Jupiter will be in Sagittarius most of May and June.

Saturn is rising about 15 minutes after Jupiter and is separated from it by less than five degrees but is considerably less bright at magnitude 0.5. This still makes it one of the brightest objects in the night sky, and it will be about the same separation from Jupiter through all of May and June. Saturn spends much of its time in Capricornus, but truly both planets are near the boundary of Sagittarius and Capricornus. They will get even closer after June as they are approaching a conjunction in December. Meanwhile, they will be at opposition within a week of each other in mid-July.

Mars is 25 degrees below Saturn on May 9 and is equally bright. However, it is still rather low as twilight begins. (Mars is rising earlier but so is the Sun.) By May 31, Mars will be magnitude 0.0 and rising about 1:45 a.m. By the end of June, it still will be rising only at 12:30 a.m. Mars is continuing to brighten as it approaches its October opposition.

Uranus is currently hidden by the Sun and **Neptune** nearly so. Neptune will be within ten degrees of Mars by the end of May and getting closer, and by the mid-June will be within two degrees of Mars. Uranus is hopeless in May but will become more visible in June (though magnitude 5.8 is at the edge of visibility under very dark skies). I expect finder maps for the two planets to become available in June or July.

Information from the April and May issues of *Sky & Telescope* and *Astronomy*, their websites, and Wikipedia.

On June 21, there will be an annular eclipse of the Sun across central Africa and southern Asia. The maximum eclipse occurs on a path crossing northern Ethiopia, southern Eritrea, Yemen, Oman, southern Pakistan, northern India, central Tibet and south-eastern China and central Taiwan.

Viewing Opportunities for Satellites (May 8 to June 13, 2020)

You can get sighting information at www.heavens-above.com, which allows you to get satellite-viewing data for 10-day periods and gives you a constellation map showing the trajectory of the satellite. The NASA site https://space-flight.nasa.gov/realdata/sightings/SSapplications/Post/JavaSSOP/JavaSSOP.html is back up. It gives coordinates at 20-second intervals from when the satellite rises, not from when it peaks. (This program requires Java. I'm currently using Internet Explorer to run it and making an exception for the site in the Java Control Panel.) I'm using its information for the International Space Station and Hubble Space Telescope, interpolating when necessary. 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 -3.8 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.

Missions to and from the International Space can change its orbit. The big one this month is the launch of astronauts aboard a Dragon capsule on May 27. This will be the first orbital launch of astronauts aboard an American rocket since 2011. There is also a Japanese cargo spacecraft launching from Tanegashima Space Center on May 20.

HST, 12 May 2020

Time	Position	Elevation
5:58 a.m.	231°	20
5:59	212	26
6:00	185	30
6:01	158	26
6:02	140	20

HST, 13 May 2020

Time	Position	Elevation
5:48 a.m.	231°	19°
5:49	213	25
5:50	188	28
5:51	162	25
5:52	144	19

ISS, 14 May 2020

Time	Position	Elevation
5:31 a.m.	338°	19°
5:32	356	30
5:33	38	39
5:34	79	30
5:35	98	19

ISS, 14 May 2020

Time	Position	Elevation
10:11 p.m.	219°	22°
10:12	212	42
10:13:16	133	76
10:13:44	74	60

Vanishes into Earth's shadow

ISS, 15 May 2020

Time	Position	Elevation
9:24 p.m.	192°	19°
9:25	172	30
9:26	132	38
9:27	92	29
9:28	73	19

ISS, 16 May 2020

Time	Position	Elevation
5:32 a.m.	299°	22°
5:33	286	39
5:34	225	60
5:35	164	39
5:39	150	21

ISS, 17 May 2020

Time	Position	Elevation
9:25 p.m.	246°	21°
9:26	260	38
9:27	319	58
9:28	19	38
9:29	34	21

HST, 26 May 2020

Time	Position	Elevation
10:18 p.m.	229°	20°
10:19	211	27
10:20:18	183	31
10:20:29	178	31

Vanishes into Earth's shadow

HST, 27 May 2020

Time	Position	Elevation
10:05 p.m.	231°	20°
10:06	212	26
10:07	186	30
10:08	170	27
Vanishes into Earth's shadow		

HST, 28 May 2020

Time	Position	Elevation
9:54 p.m.	232°	19°
9:55	213	25
9:56	188	28
9:57	163	25
Vanishes into Earth's shadow		

ISS, 2 June 2020

Time	Position	Elevation
9:37 p.m.	340	18°
9:38	0	28
9:39	37	34
9:40	73	27
9:41	93	18

ISS, 4 June 2020

Time	Position	Elevation
9:38 p.m.	305°	22°
9:39	296	41
9:40	220	72
9:41	151	41
9:42	143	22

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 Hubble Space Telescope at 5:58 a.m. on May 12, measure four fist-widths south from due west, then two fist-widths above the horizon.

All times are rounded off to the nearest minute except for times when the satellite enters or leaves the shadow of the Earth. The highest elevation shown for each viewing opportunity is the actual maximum elevation for that appearance.

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.

Highlights:

May 8, 10:45 a.m.: Coverage of release of Cygnus cargo craft from ISS. Actual release is 11:30 a.m.

May 20, noon: Coverage of launch of JAXA-HTV-9 to ISS> (Actual launch is 12:30 p.m.)

May 25, 5:45 a.m. Coverage of capture of JAXA/HTV-9 Cargo Ship by the ISS. (Capture scheduled for 7:15 a.m.)

May 27, 11:15 a.m.: Live coverage of the launch of the Space X Falcon 9 launch carrying a crew to the ISS. Actual launch will be at 3:32 p.m. This begins continuous coverage through the docking, hatch opening and welcoming ceremony. These all occur on May 28, with docking at 10:29 a.m., hatch opening at 12:25 p.m., and welcoming ceremony at 1:25 p.m.

NASA also has a weekly podcast, This Week @ NASA, which you can watch online at https://www.youtube.com/playlist?list=PL1D946ACB21752C0E . You can also get the most recent episodes at NASA.gov.

Calendar of Events

Sometime in 2020: 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.

May 4: Mercury is in superior conjunction with the Sun May 4: Peak of Eta Aquarid meteor shower.

May 9: Oklahoma Space Alliance meeting has been cancelled,

May 27: SpaceX will launch its first crew rotation to the Space Station. This will mark the return of astronauts to orbital flight aboard American spacecraft after a nine-year hiatus.

May 28 – 31: International Space Development Conference, has been cancelled

June 3: Venus is in inferior conjunction with the Sun.

June 4: Mercury is at greatest eastern elongation, 23.6 degrees from the Sun (hence can be seen after sunset).

June 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 http://www.okcastroclub.com for details.

June 13: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., probably at McMurray residence, but check.

June 30: Mercury is in inferior conjunction with the Sun.

July: Maiden flight of South Korea's Blue Whale 1. This will be world's smallest orbital rocket, but can deliver a 100 lb. cargo to orbit at a projected cost of $2 million per launch.

July 11: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

July 14: Jupiter is at opposition

July 14: United Arab Emirates launch the Mars Hope, aka as Al-Amal or the Emirates Mars Mission, from the Mohammed bin Rashid Space Center in Dubai. For more information, visit https://en.wikipedia.org/wiki/Hope_Mars_Mission

July 17, 8:00 a.m.: Launch of *Perseverance* (formerly Mars 2020) space rover and the helicopter *Ingenuity*, which will arrive on Mars in February 2021. For more information, see https://en.wikipedia.org/wiki/Mars_2020 or https://mars.jpl.nasa.gov/mars2020

July 20: Saturn is at opposition.

June 21: Annular solar eclipse visible on a path including the Democratic Republic of the Congo, Sudan, Ethiopia, Eritrea, southern Arabia, Pakistan, India southern China and Taiwan. The biggest cities on this path are New Delhi and Chongqing.

July 22: Mercury is at greatest western elongation, 20.1 degrees from the Sun (hence can be seen before sunrise).

July 23: Launch of Tianwen-1 (formerly Huoxing-1), the Mars Global Remote Sensing Orbiter, Lander and Small Rover by China. For more information, see https://en.wikipedia.org/wiki/Mars_Global_Remote_Sensing_Orbiter_and_Small_Rover. (China really needs to work out an acronym for this.)

July 27: Peak of Delta Aquarid meteor shower.

August 8: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

August 12: Peak of Perseid meteor shower.

August 13: Venus is in greatest western elongation 45.8 degrees from the Sun (hence is visible before sunrise.)

August 17: Mercury is in superior conjunction with the Sun.

September 11: Neptune is at opposition.

Last quarter of 2020 (postponed form July): Maiden flight of Ariane 6 from Kourou, French Guiana.

October 1: Mercury is at greatest eastern elongation, 25.8 degrees from the Sun (hence can be seen after sunset).

October 13: Mars is at opposition, 39 million miles from Earth.

October 20 – 21: Peak of Orionid meteor shower.

October 23: Mercury is in inferior conjunction with respect to the Sun.

October 30: Uranus is at opposition.

November 10: Mercury is at greatest western elongation, 19.1 degrees from the Sun (hence can be seen before sunrise).

December: Test flights begin for India's Gaganyaan program, which will eventually launch people into orbit.

December (Postponed from December 2019): Launch of China's Chang'e 5 lunar sample return mission. This will be the first such mission since 1976.

December 13-14: Peak of Geminid meteor shower.

December 14: Total eclipse of the Sun visible in southern Chile and Argentina, Kiribati and a long path across the wastes of the southern Pacific and Atlantic Oceans.

December 20: Mercury is in superior conjunction with the Sun.

December 21: Great conjunction between Jupiter and Saturn. The two planets will be separated by six minutes of arc.

December 22: Peak of Ursid meteor shower.

Sometime in 2021: Hope, aka Emirates Mars Mission, arrives at Mars (see July 2010).

Sometime in 2021: China launches the first module of their space station.

Sometime in 2021 [tentative]: India and Japan launch Chandrayaan-3, which will include a lander and a longlived rover which will explore craters around the Moon's South Pole in search of ice.

Sometime in 2021 [Moved from 2020].: ALINA, the Autonomous Landing and Navigation Module will be launched aboard a Falcon Block 5, and land near the Apollo 17 landing site in the Taurus-Littrow valley. It will carry two Audi lunar rovers which will try to locate Apollo 17's Lunar Rover. For more information, see https://ptscientists.com/products/alina.

January 31 – February 9, 2021: 50th anniversary of Apollo 14.

February 2021: Maiden flight of KSLV-II (aka Nuri), the first South Korean indigenous orbital launch vehicle.

February 18, 2021: Mars rover Perseverance (formerly Mars 2020) lands at Jezero Crater on Mars. It will be carrying the Mars Helicopter Scout aka Ingenuity, which will deploy in two or three months.

March 30, 2021: Launch of the James Webb Space Telescope.

April 2021: Launch of the IXPE X-Ray Telescope by Falcon 9. For more information, see https://en.wikipedia.org/wiki/IXPE.

May 26, 2021: Total eclipse of the Moon, visible from all the Pacific Ocean and lands on its rim. In Oklahoma, totality will be occurring just before moonset.

July 2021: 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.

July 26 – August 7, 2021: 50th Anniversary of Apollo 15.

August 2, 2021: Saturn is at opposition.

August 19, 2021: Jupiter is at opposition.

September 2021: First Dream Chaser cargo mission to the ISS.

October 2021: Launch of Lucy, a mission to explore Jupiter's Trojan Asteroids. See https://en.wikipedia.org/wiki/Lucy_(spacecraft) for details.

October 2021: 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.

October 2021: Launch of Hakuto -R, Japan's lunar lander. (Hakuto is Japan's Moon rabbit, so is equivalent to China's Jade Rabbit).

October 29, 2021: Venus is in greatest eastern elongation 47 degrees from the Sun (hence is visible after sunset.)

November 2021: [Moved from 2020] Maiden flight 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 NearEarth Asteroid Scout cubesat (https://en.wikipedia.org/wiki/Near-Earth_Asteroid_Scout)and a bunch of other satellites.

December 2021 [VERY tentative]: India launches its first manned orbital flight Gaganyaan-3.

Sometime in 2022: SpaceX plans to launch a human crew around the Moon. [This is speculative, reflected by this mission being postponed from 2018.]

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

June 2022: Proposed launch date of JUICE, the Jupiter Icy Moons Explorer, by the European Space Agency. The JUICE web site is https://sci.esa.int/web/juice .

June 2022: First crewed launch of an Orion space capsule.

June 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.

. July 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.

July 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 - October 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 September 26, 2022: Jupiter is at opposition.

December 2022 (Tentative): Launch of the first module of the Gateway Lunar Orbiter Platform.

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

Last quarter of 2022: Launch of the Einstein X-Ray Probe from China's Xichang Space Center.

Last quarter of 2022: Launch of RSGS (Robotic Servicing of Geosynchronous Spacecraft.

Sometime in 2023: Launch of NASA's VIPER lunar rover, which will hunt for ice near the Moon's South Pole.

March 2023: Launch of Hakuto – R Mission 2, Japan's lunar lander and

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

Sometime in 2023: OSIRIS-REx returns samples from Asteroid Bennu.

Sometime in 2023 (tentative): 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.

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

Sometime in 2024: India launches its Mangalayaan–2 Mars mission, which includes an orbiter, lander and rover.

Sometime in 2024: Planned date of Artemis 3, which will land astronauts 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.

September 2024: Launch of Japans Martian Moons Exploration, which includes a Phobos lander.

December 19, 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: First crewed flight of Russia's Orel (formerly called Federatsiya).

December 2025: BepiColombo arrives at Mercury orbit.

April 2026: Launch of Dragonfly to Titan.

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

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, 2020 (Area Code 405)

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E-mail for OSA should be sent to sydh@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-mailnsshq@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.]

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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.**