OKLAHOMA SPACE ALLIANCE

OUTREACH –September 2020

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will have
a Zoom meeting online at 2:00 p.m.
on September 12 details inside

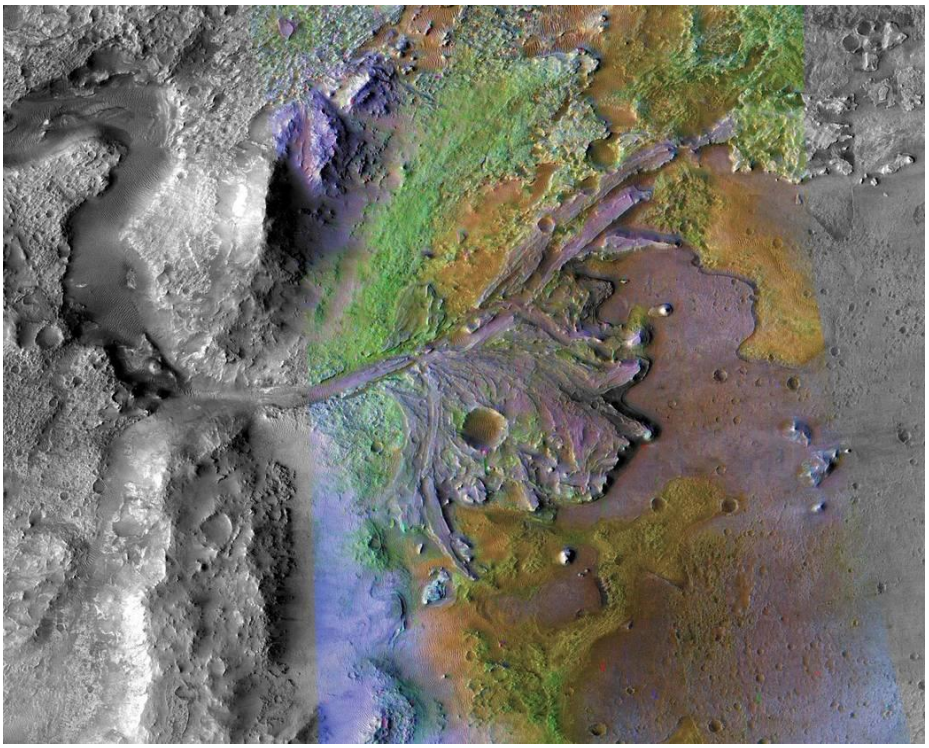

Figure 1 Mars Reconnaissance Orbiter Photograph of Jezero Crater, the Landing Site of the Perseverance Rover (NASA Gallery)

OKLAHOMA SPACE ALLIANCE OUTREACH
September 2020

September Meeting

Due to ongoing concerns of some of our doctors, we are once again delaying the restart of in-person meetings for Oklahoma Space Alliance for another month or two. This month we'll have our online chapter meeting via Zoom.

The meeting will begin promptly at 2 PM on Saturday, September12. Please sign into the meeting as close to this time as you can. If you have a camera, please start the video so we can see each other's shining faces. The free Zoom account allows only 40-minute meetings for 3 or more people, and the timer starts when the third person joins the meeting. Once that meeting times out, we can restart using the same link after 15 minutes have elapsed, so the plan will be to take a break at about 2:40 and resume for part two of the meeting at 3 PM. (Note, though, that last month Zoom extended our time so we didn't have to divide the meeting.)

For the meeting ID and password, contact Kip at 863-6173 (email cliffmcmurray at hotmail.com) or Syd Henderson at 365-8983 (e-mail sydh at ou.edu) and we will send you the information.

If you have any questions about any of this, or want to do a quick practice session to avoid hiccups on Saturday, feel free to give me a call at (405) 863-6173 in the afternoon or evening on Friday. We hope to see you Saturday.

Saturday September 12, 2020 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
3. Break
4. Oklahoma Space Alliance Chapter Business Discussion
   a. Review OSA treasurer's report
   b. Minutes of August Meeting
   c. Future Activities (Space week?)
5. Video (to be announced)
6. Chat

Minutes of July Meeting

Oklahoma Space Alliance chapter of National Space Society had its regularly scheduled meeting on July 11, 2020. However, due to the ongoing Covid-19 pandemic, we held the meeting online via Zoom. Attending the meeting were Clifford and Claire McMurray, Dave Sheely, Tim Scott, Robin Scott, and Syd Henderson. Clifford McMurray 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/Update2007.pdf, so I'll just cover the highlights.

The Dragon Crew Capsule which carried two astronauts to the Space Station can carry up to six astronauts. We watched a video of the launch and a video from the capsule after launch but before docking.

The landers are the big item for a 2024 Moon landing. We're waiting for reconciliation between the House and Senate space bills necessary for any chance for a landing by 2024.

The Space Force will have a more fluid organization than the USAF since there are so few people in it.

A number of Chinese commercial space companies are developing reusable spacecraft.

Space companies impacted by Covid-19 are looking for foreign investors. They can wind not being able to accept Department of Defense contracts.

We now have $656.65 in our account and $267 in cash for a total of $923.65.

--Minutes by OSA Secretary Syd Henderson

Minutes of August Meeting

Oklahoma Space Alliance chapter of National Space Society had its regularly scheduled meeting on August 8. However, due to the ongoing Covid-19 pandemic, we held the meeting online via Zoom. Attending the meeting were Clifford and Claire McMurray, Dave Sheely, Tim Scott, Syd Henderson, and Seth Potter from the LA Chapter. OSA president Clifford McMurray 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/Update2008.pdf.

Kip McMurray (Update) and Syd Henderson (Outreach) won an award for chapter newsletters.

We watch videos of the Starship test launch, and the launches of *Hope*, *Tianwen-1*, and Mars 2020 (*Perseverance)*, the last three of which are all going to March where they'll arrive in February 2021

We watched the landing of the Dragon Crew Capsule *Endeavour*. The landing was complicated by a bunch of boaters who approached the landing site off the coast of Pensacola, Florida, passing through a cordon of Coast Guard vessels. The Dragon capsule emits dinitrogen tetroxide which exists in equilibrium with nitrogen dioxide and is dangerously poisonous. We also watched a video of the undocking, reentry, and landing. The capsule recovery was done by a ship from SpaceX, not by aircraft carrier. All the American manned space missions though Skylab used aircraft carriers to retrieve the astronauts and generally the capsules.

We watched a video of Elon Musk talking about the return of *Endeavour*, and a video of the astronauts being interviewed after the landing.

Kip knows Greg Autry, who has been nominated as NASA's Chief of Financial Operations. Autry was on the NSS board for several years.

We looked at the Democratic platform on space, which was brief and blandly supportive. (The Republican one will presumably come up this month.)

George Whitesides, the former executive director of NAA, is stepping aside as CEO of Virgin Galactic, but will still be with them as Chief Space Officer.

We watched a video of SpaceX catching both halves of the fairings to one of their Falcon launches.

The *Endeavour* crew returned with a flag that had flown to space on the first orbital shuttle launch, and had been left aboard the ISS by the last shuttle mission until it could be returned the next time an American rocket took people to the ISS, which took nine years. Note that one of the *Endeavour* astronauts was on both missions.

Business meeting:

When the ISDC returns, should we have the awards at an evening function?

Claire McMurray now has the Chapters Coordinator Awards named after her.

No change in the amount in our treasury.

--Minutes by OSA Secretary Syd Henderson

Also: Craig Smith the new Executive Director of the Oklahoma Space Industry Development Authority contacted us and wanted to know more about us and how we can work together. I'm adding him to our e-mail and mailing lists and Kip has also been communicating with him. (I believe Dave was already.)--SFH

Space News

Mars is approaching opposition. See "Sky Viewing" below.

The SLS baseline costs are not surprisingly going well over the estimates from 2019. Congress had approved $7 billion based on 2019 fiscal numbers, but the new baseline cost is $9.1 billion. There is also a $2.4 billion commitment to ground systems. (These numbers, however, are not that far above those in the Government Accountability Office report last April.)

The first unmanned flight of the SLS to the Moon, Artemis 1, is still planned for November 2021.

https://www.space.com/nasa-sls-megarocket-cost-rise-congress-alert.html

Chinese villagers near a school in Lilong village in Luonan County in Shaanxi province got a bit of an alarm when a first stage of a Long March 4B rocket crashed and exploded. China is usually good about warning and evacuating its citizens, and there's no immediate word whether anyone was hurt, though clearly people were close enough to photograph it (which also indicates they were warned what to expect).

China has three launch sites that are far inland, so occasionally launches will rain debris on the countryside. This particular launch site, Xichang, is located in Szechwan province near the eastern edge of the Tibetan plateau. There was a fatal accident caused by a launch here in 1996.

The two other inland launch sites are one in Inner Mongolia, and one in Shanxi Province (which sounds like a dangerous place to have a launch site with the lower part of the Yellow River east of it). There is also a coastal site on Hainan Island which only handles Long March 5 and 7 launches.

Black holes come in a variety of sizes, some of them being produced by the collapse of massive stars, some much more massive ones being at the center of globular clusters and really, really massive ones at the center of galaxies. There's also the possibility that some mini-black holes may have been produced during the Big Bang. However, there is a mass gap: supernova explosions cannot produce black holes with masses greater than 65 solar masses and 120 solar masses. The reason is that the stars producing these would be so hot that the energy would start producing electron-positron pairs in the reverse of the usual annihilation reaction of such pairs. This suddenly reduces the radiation pressure keeping the star from collapsing, which means the star starts shrinking, gets hotter, produces more electron-positron pairs…and the runaway effect blows the star apart completely, producing what is called a hypernova (a super-duper supernova) but no black hole. (The progenitor stars would have a mass between 130 and 200 solar masses. Stars with more than 200 solar masses, several of which exist in the Large Magellanic Cloud) collapse directly into black holes without a supernova explosion, although they also lose mass so rapidly, they might fall into the hypernova danger zone.

Anyway, on May 21, 2019, the LIGO and (European) Virgo gravitational wave detectors detected the collision of two black holes with masses 66 and 85 times that of the Sun, which you'll notice were both in that mass gap. The merged black hole has 142 solar masses, which takes it beyond the far side of the mass gap. (The other nine solar masses were lost to gravitational waves, some of which LIGO and Virgo detected.) If the theory of black holes is correct, the two black holes that collided must each have been created by earlier black hole collisions. If not, we may need exciting new science, but I expect the serial collision theory to be proven correct.

The collision took place seven billion years ago in a galaxy far, far away. Two detectors aren't quite enough to narrow the location down within a few degrees, but it's just possible that a visual component may have been detected, not from the merger itself, since the holes were, after all, black, but from the merged black hole passing through an accretion disc surrounding a super-massive galactic black hole.

This discovery makes me think there are probably intermediate mass black holes in the Large Magellanic Cloud. There are a lot of very massive stars in the Tarantula Nebula, some of which will collapse directly into black holes, but also likely a bunch of stars around 100 solar masses in a dense region, and they'll produce large black holes that will merge into black holes in the mass gap.

Enstatite chondrites are a kind of meteorite that are thought to be similar to the rocks that formed the inner planets of the solar system. Since these were thought to be dry, it has been assumed that the inner planets formed dry and got their water later, which seemed odd to me because the Earth's mantle is known to contain water. And now an analysis of enstatite chondrites shows that they contain 0.08 to 0.54% water. That may not seem much, but they were assumed to have none at all. The team doing the analysis thinks they could have supplied three times the volume of water that is now in the Earth's oceans. This is in addition to any that may have arrived by comet or meteorites since then (maybe the equivalent of 5% of the oceans' water).

I'm guessing this is still a substantial underestimate, given that these meteorites have had five billion years to lose their water, and a lot of the protoplanetary objects that formed the Earth may have been larger and wetter. But, in any case, this demonstrates that the inner planets (and the Moon too) probably had quite a bit of water from the beginning. There may well be more water in the Earth's mantle than they're calculating.

The previous leading candidates for supplying water to the inner solar system were the carbonaceous chondrites, which formed farther out in the solar system and can contain 3 to22% water, so a far smaller mass of them would more than suffice. However, this theory had some problems. Not only are these meteorites only 5% of all meteorites, the isotope composition of their water and metals is wrong. Enstatite chondrites formed in the inner solar system and the isotope composition of their water and metals is almost exactly that of the Earth.

[The original article this report is based on is "Earth's Water May Have Been Inherited from Material Similar to Enstatite Chondrite Meteorites," by Laurette Piani, Yves Marrocchi, Thomas Rigaudier, Lionel Vacher, Dorian Thomassin and Bernard Marty, https://science.sciencemag.org/content/369/6507/1110, but I mostly used articles in *New Scientist*, *Sky & Telescope*, Wikipedia and my own knowledge and speculations.]

Sky Viewing

The only important meteor shower in September and October, **Orionid meteor shower** is always one of the more prominent of the year and this year peaks on the night of October 20 - 21. There are about twenty meteors per hour in most years, with the radiant northeast of Betelgeuse in the direction of Gemini. This year will be a good year for viewing since the Moon will not be in the sky. The shower lasts a week centered around the October 21 peak.

The Orionids are one of the two meteor showers associated with Halley's Comet, the other being the Eta Aquariids in May.

The more impressive event in October is the arrival of **Mars** at opposition on October 13. Because of the eccentricity of both planets' orbits (particularly Mars), the two planets are not necessarily closest at opposition. Mars will actually be closer to Earth on October 6, when it will be 38.1 million miles away. This is not quite as close as in 2018 but is still closer than it will be until 2035.

Mars is already magnitude -2.0 and appears around 20 seconds of arc in diameter. It is also gradually brightening, and will be magnitude -2.6 at opposition, at which point it will be almost as bright as Jupiter was in July. (Jupiter was magnitude -2.7.) It will also appear slightly wider, at 23 seconds of arc. It still will look like a dot to the naked eye since it will be an eightieth the apparent diameter of the Moon.

Although this opposition isn't as close as that of 2018, Mars will be more prominent to viewers in the Northern hemisphere. That is because that opposition occurred in late July, and the ecliptic (the apparent path of the Sun which the major planets also approximately follow) was low in the sky at time of the opposition. Mars was in fact in Capricorn about 25 degrees south of the Celestial Equator. This year it will be in southern Pisces about five degrees *north* of the Celestial Equator. In other words, it will be thirty degrees higher above the horizon. Mars will pass due south around 1:00 or 1:30 a.m. due to Daylight Saving Time.

The October issues of *Sky and Telescope* and *Astronomy* have lots of information on observing Mars during this opposition.

Mercury is currently a few weeks past superior conjunction with the Sun and is still lost in twilight in the evening but reaches greatest elongation on October 1. This normally would suggest that Mercury should be pretty visible, but at this time of year the ecliptic makes a low angle at sunset and Mercury will be only three degrees above the horizon a half-hour after sunset. This makes it almost impossible to spot. It also is inferior conjunction with the Sun on October 25. I suspect this opposition is just fine in the Southern Hemisphere.

Venus is still a morning star and moving away from us. Venus is currently in a gibbous phase, which for that planet means it's growing dimmer, the higher percentage of its surface being lit not making up for its greater distance. (Mercury is just the opposite since it's farther away than Venus at closest approach.) Consequently, it is now magnitude -4.2, a full half-magnitude less bright than at maximum. It's still easily the brightest planet. Venus is currently in Cancer, and over the next couple of months will move through Leo (visiting Regulus) and into Virgo.

Jupiter and **Saturn** grew a bit farther apart during their retrograde motions around opposition and are now eight degrees apart. They are respectively magnitudes -2.5 and magnitude 0.3 and are south at sunset. Jupiter is easy to spot. Saturn is nearly a fist-width to the left of it. Both are in the constellation Sagittarius and will be through October. They are fading a bit, Jupiter falling to magnitude -2.2 by the end of October, and Saturn to magnitude 0.6. They are also getting closer together, their distance falling to 5.2 degrees by October 31. They will continue to approach each other until the Great Conjunction on December 21, when they will only be six minutes of arc apart, a fifth the diameter of the Moon. That will also be in early evening, so may be a little hard to see, but we get to see the runup very easily.

Incidentally, although you need a pretty strong telescope to see it, **Pluto** will be on a straight line between Saturn and Jupiter until the beginning of November.

Uranus, located in a dim area of Aries, is nevertheless approaching its opposition on Halloween and will brighten a bit from 5.8 to its maximum of 5.7. This is theoretically on the edge of naked-eye visibility in totally dark skies, but I'd recommend at least a strong pair of binoculars if only to distinguish it from background star.

Neptune is at opposition on September 11 in a rather obscure region of Aquarius, a constellation which it will be in through early 2023. It is always about magnitude 7.8

You can find sky charts for Uranus and Neptune at https://in-the-sky.org/findercharts/09uranus_2020_2.png and https://in-the-sky.org/findercharts/10neptune_2020_2.png, and at https://skyandtelescope.org/wp-content/uploads/UranusNeptune2020_BW_WebFinder.pdf.

Viewing Opportunities for Satellites (September 12 – October 12, 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 times below are from the NASA site https://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/JavaSSOP/JavaSSOP.html. 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 Station can change its orbit. The only launch during this time period to the ISS is a resupply mission by Northrop Grumman on September 29.

ISS, 16 September 2020

Time	Position	Elevation
8:46 p.m.	220	22°
8:47	213	42
8:48	133	77
8:49	59	42
8:50	53	22

ISS, 17 September 2020

Time	Position	Elevation
7:59 p.m.	193°	19°
8:00	174	30
8:01	133	39
8:02	92	30
8:03	73	19

ISS, 19 September 2020

Time	Position	Elevation
8:00 p.m.	248°	21°
8:01	264	38
8:02	321	55
8:03	17	37
8:04	32	21

HST, 29 September 2020

Time	Position	Elevation
6:58 a.m.	230°	20°
6:59	212	27
7:00	185	30
7:01	158	26
7:02	139	20

HST, .30 September 2020

Time	Position	Elevation
6:48 p.m.	231°	19°
6:49	213	25
6:50	187	28
6:51	162	25
6:52	143	19

ISS, 5 October 2020

Time	Position	Elevation
8:19 p.m.	336°	19°
8:20	355	31
8:21:19	38	40
8:22:54	66	36
Vanishes into Earth's shadow		

ISS, 7 October 2020

Time	Position	Elevation
8:21 p.m.	298°	21°
8:22	283	38
8:23	224	57
8:23:58	167	37
8:24:23	159	29

ISS, 8 October 2020

Time	Position	Elevation
7:33 p.m.	318°	23°
7:34	327	42
7:35	48	74
7:36	124	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 International Space station 6:58 a.m. on September 29, measure four fist-widths south of 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:

September 29, 9:00 p.m.: Launch coverage begins for the launch of Northrop Grumman's CRS-14 Cygnus Cargo Mission to the ISS from Wallops Flight Facility in Virginia. Actual launch is 9:26 p.m.

October 3, 2:45 a.m.: Coverage begins of the rendezvous and capture of the Cygnus Cargo Craft to the IRS. Capture is scheduled at 4:15 a.m. with installation around 6:00 a.m.

There will certainly be coverage of the Soyuz manned launch to the IRS on October 14 and the astronaut return on October 22, but the broadcast schedule doesn't extend farther than October 6 at this time. The SpaceX Crew-1 mission will also get lots of coverage, and may be as early as October 23.

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

September 11: Neptune is at opposition.

September 12: Oklahoma Space Alliance meeting, 2:00 p.m., via Zoom.

September 29: Northrop Grumman Cygnus spacecraft will deliver cargo the ISS.

Last quarter of 2020 or early 2021 (postponed from 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 10: Oklahoma Space Alliance meeting, 2:00 p.m., via Zoom.

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

October 14: NASA astronaut Kate Rubins and cosmonauts Sergey Ryzhnikov and Sergey Kud-Sverchkov are to be launched from the Baikonur Cosmodrome to the ISS.

October 20 – 21: Peak of Orionid meteor shower.

October 20: *OSIRIS-REx* will contact the surface of asteroid Bennu as part of its sample-return mission.

October 22: Cosmonauts Anatoly Ivanishin and Ivan Vagner and NASA astronaut Chris Cassidy return from the ISS, landing in Kazakhstan.

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

October 23 at the earliest: SpaceX Crew-1 mission takes Michael Hopkins, Victor Glover and Shannon Walker to the ISS. OSA member Mike Hopkins informs me he is not the one going.

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 sun-rise).

November 14: Oklahoma Space Alliance meeting, 2:00 p.m., probably via Zoom.

November 24-25: (Postponed from December 2019): Launch of China's Chang'e 5 lunar sample return mission. This will be the first mission of this type since 1976. For more information, see https://en.wikipe-dia.org/wiki/Chang%27e_5

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

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 19: 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: China launches the first module of their space station.

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 3, 2021: Peak of Quadrantid meteor shower.

January 23, 2021: Mercury is at greatest eastern elongation, 18.6 degrees from the Sun (so can be seen after sunset).

January 23, 2021: Saturn is in conjunction with the Sun.

January 28, 2021: Jupiter is in conjunction with the Sun.

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

February 2021: Hope, aka Emirates Mars Mission, arrives at Mars. For more information,, see //en.wikipedia.org/wiki/Emirates_Mars_Mission .

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

February 8, 2021: Mercury is at inferior conjunction with the Sun,

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 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.

March 6, 2021: Mercury is at greatest elongation, 27.3 degrees west of the Sun (hence can be seen before sunrise).

March 10, 2021: Neptune is in conjunction with the Sun.

March 26, 2021: Venus is at superior conjunction with the Sun.

April 18, 2021: Mercury is at superior conjunction with the Sun.

April 22, 2021: Peak of Lyrid meteor shower.

April 30, 2021: Uranus is in conjunction with the Sun.

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

June 10, 2021: Annular eclipse of the Sun. The eclipse passes through the Arctic from Russia just north of Kamchatka, almost to the North Pole, back through northwestern Greenland, Baffin Island, and Hudson Bay. Until terminating in central Ontario north of Lake Superior. In other words, few people will be able to see the annular eclipse, though a partial eclipse will be visible in the northeastern United States, and eastern and central Canada.

June 10, 2021: Mercury is in inferior conjunction with the Sun.

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

August 2, 2021: Saturn is at opposition.

August 19, 2021: Jupiter is at opposition.

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

October 16 – November 5, 2021: Launch window for Lucy, a mission to explore Jupiter's Trojan Asteroids. See https://en.wikipedia.org/wiki/Lucy_(spacecraft) for details.

October 2021: 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.

October 1, 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 29, 2021: Venus is in greatest eastern elongation 47 degrees from the Sun (hence is visible after sunset.)

October 31, 2021: [Postponed from April] Launch of the James Webb Space Telescope. For more information, see https://en.wikipedia.org/wiki/James_Webb_Space_Telescope

November 2021: [Moved from 2020] Launch of 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 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.]

January 2022: [Moved from 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.

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

May 22 - June 10, 2022: Launch window for JUICE, the Jupiter Icy Moons Explorer, by the European Space Agency. The JUICE web site is https://sci.esa.int/web/juice .

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

. 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 to December 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.

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

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 2023: (Tentative): Launch of the first module of the Lunar Orbiter Platform- Gateway.

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

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.

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

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 Japan's 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)

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

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