

OKLAHOMA SPACE ALLIANCE

OUTREACH –November 2020

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will have
a Zoom meeting online at 2:00 p.m.
on November 14 details inside



Figure 1 Jupiter and Saturn at 6:30 p.m. on December 21 (Starry Night)

(Note: the object in the center is a background star not a moon)

OKLAHOMA SPACE ALLIANCE OUTREACH November 2020

November Meeting

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, November 14. 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.)

To join the meeting, go to <https://us04web.zoom.us/j/79444489279?pwd=R2hLS2R3RnVoUFVMcS9UaDRWMW9sUT09> If for some reason the link doesn't work, 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 updated 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 Kip a call at (405) 863-6173 in the afternoon or evening on Friday. We hope to see you Saturday.

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 12 at the McMurrays.

Saturday November 14, 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 September and October
 - c. Officer nominations
 - d. Christmas party/elections
5. Video (to be announced)
6. Chat

Minutes of September Meeting

Oklahoma Space Alliance chapter of National Space Society had its regularly scheduled meeting on September 12, 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, and Syd Henderson. 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/Update2009.pdf>, so I'll cover the highlights that aren't covered there.

The astronauts aboard the ISS station have been investigating a small leak and haven't been able to locate the source. This is a smaller leak than that in the Soyuz in 2018, which was traced to an apparent micrometeorite puncture.

Five percent of Station resources are now allocated to private companies.

Change'8 may feature an inflatable module. It will land on the Moon roughly in 2023.

We watched a video on Frank Culbertson, who was aboard the ISS on 9/11/2001 and filmed NYC from the ISS, capturing the smoke plume from the burning towers. The sound didn't work on this video, but we also had the actual camera footage which spoke for itself.

Kip found some interesting quotes from NASA director Bridenstine in two articles on Lunar Resources. See <https://www.space.com/nasa-buy-moon-dirt-private-companies.html> for instance.

We read an article and video reproducing Nixon's speech on the Apollo 11 disaster that never happened. This was the speech prepared in case the astronauts were stranded on the Moon and was never needed. The video was a demonstration on how convincing such fakes can now be with computer technology.

We watched part of video on Terminator Tapes which would be used to remove satellites from orbit, but once again the sound failed. [I recommend trying the closed caption option when this happens despite the obvious silliness you can get from bad captioning.]

Business meeting: We now have \$642.21 in the bank account (after Syd is reimbursed for newsletter printing costs) and \$267 in cash, for a total of \$909.21.

We discussed the caution needed from using images from NASA (You have to make sure the image is actually public domain.) We also talked a little bit of the proposal to create a separate version of the NSS logo for chapters. Generally, we disapproved, but our Chapter has its own logo so we wouldn't use the chapters logo anyway.

Apparently there was no actual platform from the Republican convention although they generally approved of what Trump is doing, including his proposals for returning to the Moon.

--Minutes by OSA Secretary Syd Henderson
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Minutes of October Meeting

Oklahoma Space Alliance chapter of National Space met on October 17, 2020. (The meeting was moved from the second Saturday since several regulars had to be out of town.) Attending were Cliff and Claire McMurray, Tim Scott, Dave Sheely and Syd Henderson. 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/Update2010.pdf>, so I'll cover the highlights that aren't covered there.

We watched a video of ISS Astronaut Kate Rubins voting electronically from space.

There was an apparent finding that phosphine had been found in the atmosphere of Venus. BepiColombo will not go close enough to Venus on its current flyby to detect phosphine but will on the next flyby. [The phosphine signature now looks to have been a false positive, but I'm sure BepiColombo will still look.

RocketLab is planning a 2023 private launch to Venus. ESA, Russia and India are also planning Venus flybys.

UAEs Rashid Lunar Rover would hitch a ride with another country's organization. If successful, the United Arab Emirates would be the fourth nation to make a soft Moon landing. The rover would be 10 centimeters high, half a meter across and weigh ten kilograms. They want to take a look at electrostatic dust.

All of Bigelow's employees are in furlough due to the COVID-19 emergency.

We watched a video of the *Astra* crash.

The Momentus satellite transport service has their first launch next year. They will transport satellites from a temporary parking orbit to where the customer wants them to orbit

We watched a promotional video of ICON, which is working on a system to use 3D printing for construction in space.

Tom Cruise apparently really is going to film on the ISS. His director is Doug Liman, known for *The Bourne Identity* as well as *Edge of Tomorrow* and *Mr. and Mrs. Smith*.

Estée Lauder would not be the first company to shoot a commercial in space [though probably would be the first to do it on the ISS]. The Russians shot commercials aboard *Mir*.

Brian Binnie, whose autobiography is *The Magic and Menace of SpaceShipOne* was the man who flew the flight that won the X-Prize,

Business:

We now have \$642.21 in the bank account and \$267 in cash, giving us \$909.21 total.

Next month we need to discuss whether to have a Christmas Party and whether and how to collect dues [and hold elections]

Computer experts are remastering Apollo and Gemini films the way Peter Jackson did for World War I footage in "They Shall Not Grow Old." We watched a remastered video of a Gemini spacewalk.

--Minutes by OSA Secretary Syd Henderson

Space News

In the November 3 election, first-term Oklahoma Congresswoman Kendra Horn lost her bid for reelection and thus her seat as Chair of the Subcommittee on Space and Aeronautics. On the other hand, retired astronaut Mark Kelly was elected Senator from Arizona and presumably will be a space advocate there although it looks likely that the Democrats will not have control of the Senate. Kelly's identical twin brother Scott Kelly is also a retired astronaut, and they were famously the subject of a twins experiment when Scott was in space while Mark was on the ground. Mark's wife is former Congresswoman Gabrielle Giffords who was nearly killed in an assassination attempt in 2011. (Six people were killed in the assault.) Kelly and Giffords are both gun control advocates supporting universal background checks.

NASA Administrator Jim Bridenstine says he won't remain in the role after Joe Biden is sworn in as President, even if Biden asks him: "You need somebody who has a close relationship with the president of the U.S. ... somebody trusted by the administration including OMB, [National Space Council](#), National Security Council," Bridenstine told *Aviation Week*, "I think I would not be the right person for that in a new administration." This would be a shame since so much of NASA's current path is due to him, so I hope Biden will at least have the courtesy ask him. [Source: <https://www.space.com/nasa-chief-bridenstine-step-aside-president-biden>.]

The LIGO and Virgo teams have released their second set of gravitational wave detections. With these 39 detections, the total number of detections is now an even fifty. Nearly all the second set of detections result from pairs of black holes colliding. Indeed, only one may be from two neutron stars colliding, which suggest the previous such detection involved a lot of luck. In this case the collision was not seen in electromagnetic radiation, which is why its uncertain that it is indeed a neutron star collision. (I assume one of the possibilities is a neutron star colliding with a black hole, which would not be good for the neutron star.)

Interestingly, in seven of the collisions, one of the stars has a mass more than 50 times that of the Sun. It is thought that a supernova cannot produce a black hole with a mass between 50 and 130 solar masses because the star would either explode completely, or, if its core was more than 130 solar masses, it would quietly collapse into a black hole with no supernova at all. If this is true, these seven black holes much each have formed from the coalescence of smaller black holes. One of the black holes has a mass ninety times that of the sun, which suggests at least one of the black holes from which it formed had a mass more than fifty percent of the Sun (since some percent of the mass would have turned into gravitational waves).

Coinciding with the date of this month's Oklahoma Space Alliance meeting is the launch of SpaceX second crewed mission to the International Space alliance at 6:49 p.m. on November 14. Despite it being the second mission, it is designated as Crew-1 since the previous mission was considered a demo mission. The Crew-1 Dragon spacecraft is named *Resilience* and will carry four astronauts, Michael Hopkins (not the OSA member), Victor Glover, and Shannon Walker from NASA and Soichi Nogushi from the Japanese Aerospace Exploration Agency (JAXA). These four members of Expedition 64/65 will spend seven months in space. They will join cosmonauts Sergey Ryzhikov and Sergey Kud-Sverchkov and NASA astronaut Kate Rubins, who boarded the ISS in mid-October and will stay on the ISS until April 18, 2021. The Crew-1 astronauts will be joined by three Russian cosmonauts on April 1 (which you'll notice means there will briefly be ten people on the ISS) and stay on the ISS until June 2021.

Sky Viewing

Since *Outreach* is a bimonthly newsletter, so this section includes data through the end of the year, which is fortunate because several major astronomical events happen in December.

The big one is the **Great Conjunction of Jupiter and Saturn**, which takes place at 8:00 a.m. on the morning of December 21, at which point Jupiter and Saturn will be separated by only a tenth of a degree, a fifth of the diameter of the

Full Moon. This, of course, is during the daytime, but the two will be within half of a degree (a Moon width) from December 16 through 26. The approach is the closest within 400 years, and the earlier one wasn't easily visible. The last one that was closer and easily visible was in 1226.

Great Conjunctions occur every 19.6 years and even the worst ones have a separation of less than a degree and a half. If they occur when the planets are near opposition, you can have multiple conjunctions. For example, there were three in 1981, three in 1940-41, and three in 1821. The most famous triple conjunction was in 7 B.C. and was thought by Johannes Kepler to possibly be the Star of Bethlehem. The next triple conjunction isn't until 2239.

A Great Conjunction is a slow thing, and Jupiter and Saturn are already a little more than four degrees apart. They will be two degrees apart on December 1, with Jupiter conspicuous in the west at magnitude -2.0 and Saturn distinct to its left at magnitude 0.5. From December 12 through 29, they will be less than a degree apart, and, as I mentioned, within a half-degree from December 16 through 26. This is close enough to see both through binoculars at the same time, and on December 20-21 they will be within the same telescope view.

The closest possible Great Conjunction would be an occultation of Saturn by Jupiter. The last of those was 8,000 years ago.

Unfortunately, Jupiter and Saturn are both approaching late January conjunctions with the Sun, so they are getting low in the west after sunset. At closest approach, they will be fourteen degrees above the horizon 45 minutes after sunset. Jupiter should still be easy to see, but binoculars will help seeing Saturn.

We have three meteor showers during November and December, of which the Geminids are the really big event, but first we get the **Leonid meteor shower** which peaks on the morning of November 17 with a likely 15 meteors per hour. This is just a couple of days after the New Moon so there won't be any interference from other celestial bodies. The Leonids produce "meteor storms" about every 33 years, but we are 18 years since the last one and we'll have to wait a while.

The **Geminid Meteor Shower**, on the other hand, should be the best of the year. In recent years, it has produced more meteors than any other shower, and this year the peak is the day before the New Moon and there will be no interference from that quarter at all. As long as the weather is decent (dress warm!), and you find a dark sky you should see quite a few meteors.

The Geminids peak on the night of December 13-14. Although peak time is about 1:00 p.m., you should be able to see them all night. The radiant (the point from which the meteors originate) is near the second magnitude star Castor, which forms a conspicuous pair with its twin brother, first-magnitude Pollux. Gemini is north and slightly east of Orion (and is not to be confused with Auriga which is due north of Orion and contains the very bright star Capella.) A line from Rigel through Betelgeuse will take you to the vicinity of Castor and Pollux.

At their peak, the Geminids produce about 150 meteors per hours. The shower continues the next night, but at a rate of 30 – 40 per hour.

The **Ursid** meteor shower is a poor second cousin to the Geminids, producing maybe 10 meteors per hour, but meteors appear from December 17 -26, peaking on December 22. That is during the first quarter moon, which graciously leaves the sky before the Ursid's morning peak. The radiant is in Ursa Minor, the Little Bear, aka the Little Dipper, near the second-magnitude star Kochab. This is near the Celestial North Pole and Polaris, and Kochab is nearly as bright as Polaris, so easy to find in a dark sky for meteor watching.

Finally, there is a **total solar eclipse** on December 14, which is notable for the amount of barren ocean it crosses. The only land masses it crosses are Araucanía in south-central Chile, and northern Patagonia in Argentina. The path of the eclipse starts in the middle of the South Pacific and ends up just short of the coast of Namibia in southern Africa.

Mercury is currently visible above the eastern horizon before sunrise and growing brighter, reaching magnitude -0.7 on November 13. It will be roughly eleven degrees above the horizon forty-five minutes before sunrise. It may help that on that morning there will be a crescent Moon standing five degrees (a half-fist width) above Mercury. If you can find a spot with a clear eastern horizon, you may be able to see it for a couple of weeks afterward, Mercury will get harder to see in December as it approaches superior conjunction with the Sun on December 20 and won't return until 2021.

Venus is still at magnitude -3.9 in the morning, which is still the brightest planet in the night sky, but off its magnitude -4.7 peak. It's rising about three hours before the Sun, which will fall to two hours by the end of November, and ninety minutes by the end of December. It's not growing appreciably dimmer on the far side of its orbit (since our distance to it isn't growing as rapidly) and won't reach superior conjunction until March 26.

Mars, which was noticeably brighter than Jupiter for a couple of weeks around its October 13 opposition, is still brilliant in the east at sunset and the west at sunrise. Currently it's magnitude -1.8 in the constellation Pisces. As it moves

away from us, its brightness will fall to magnitude -1.1 by the end of November (not as bright as Sirius), and to magnitude -0.3 by the end of December. Mars will spend all this time travelling across Pisces.

Uranus, which moves very slowly across the constellation, will be in an inconspicuous part of Aries for all of November and December, and, since its distance doesn't change very much either, will be magnitude 5.7 all that time. It's just visible under very dark skies for those with excellent eyesight, but the rest of us would need binoculars or a telescope. It's easier to find with a telescope if you know where to look because it'll show a (small) disk, not a point. Uranus is currently about twenty degrees to the lower left of Mars. The December issue of *Astronomy* has a good guide on how to find it and there are also the star charts below.

Neptune will be in Aquarius for quite a few years. Although it's magnitude 7.8, which requires at least good binoculars, it may be easier to find since it's about a degree northeast of the fourth magnitude star Phi Aquarii and moves very slowly among the stars. (It's also stationary on November 29.)

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 (November 14 – December 14, 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. SpaceX's Crew-1 mission launches on the morning of November 14. There is also a SpaceX cargo mission which will launch on or slightly after December 2.

HST, 13 November 2020

Time	Position	Elevation
6:35 a.m.	228	21°
6:36	191	28
6:37	181	32
6:38	153	28
6:39	134	21

ISS, 18 November 2020

Time	Position	Elevation
6:49 p.m.	217	22°
6:50	208	41
6:51:10	136	72
6:52:20	108	69
Vanishes into Earth's shadow		

HST, 14 November 2020

Time	Position	Elevation
6:24 a.m.	230	20°
6:25	211	27
6:26	183	31
6:27	156	27
6:28	137	20

ISS, 19 November 2020

Time	Position	Elevation
6:02 p.m.	190	18°
6:03	171	28
6:04	132	36
6:05	94	29
6:06	75	18

HST, 15 November 2020

Time	Position	Elevation
6:15 a.m.	231	20°
6:16	212	26
6:17	186	30
6:18	159	27
6:19	140	20

ISS, 21 November 2020

Time	Position	Elevation
6:03 p.m.	245	21°
6:04	259	39
6:05	319	60
6:06	20	39
6:07	34	22

HST, 6 December 2020

Time	Position	Elevation
5:51 p.m.	231	20°
5:52	212	26
5:53	174	30
5:54	148	26
5:55	129	20

HST, 7 December 2020

Time	Position	Elevation
5:42 p.m.	223	20°
5:43	204	27
5:44	177	31
5:45	149	27
5:46	130	20

ISS, 7 December 2020

Time	Position	Elevation
6:21 p.m.	338	18°
6:22	357	28
6:23	36	36
6:24:09	84	28
6:24:29	84	25

Vanishes into Earth's shadow

ISS, 9 December 2020

Time	Position	Elevation
6:21 p.m.	302	22°
6:22	291	40
6:23	224	66
6:24	158	40
6:25	147	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 at 5:46 p.m. on December 7. measure four fist-widths south from due east, 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 (times are Central Standard Time):

November 14, 2:30 p.m.: Coverage Launch of SpaceX Crew-1 mission aka *Resilience* to the ISS Actual launch is at 6:49 p.m., and coverage will be continuous through hatch opening,

November 15, 3:20 a.m. Coverage starts of the docking of *Resilience* with the ISS. Welcoming Ceremony is at 6:00 a.m.

November 18, 7:30 a.m.: Live coverage of the spacewalk by Sergey Ryzhikov and Sergey Kud-Sverchkov. Spacewalk actually starts at 8:30 a.m.

December 2: SpaceX launches a resupply mission to the ISS containing the Bishop Airlock Module. TV schedule hasn't been announced but the launch is at 11:50 a.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

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

November 14: 6:49 p.m. Launch of SpaceX Crew mission (*Resilience*) to the International Space Station.

November 15, time TBS: Launch of *Alchemy* and *Augury*, aka DragRacer A and B, via an Electron rocket. This will test the feasibility of deorbiting spacecraft by electromagnetic tether. *Alchemy* is the tethered satellite that will deorbit. *Augury* will remain in orbit for nine years.

November 19 – 23 (exact date TBD): Launch of SpaceShipTwo *VSS Unity* on a crewed suborbital flight.

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.wikipedia.org/wiki/Chang%27e_5

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

December 2, 11:50 A.M.: SpaceX launches a resupply mission to the ISS containing the Bishop Airlock Module.

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 18: SpaceX's SmallSat Rideshare mission *Transporter 1* mission which will launch the space tug *Sherpa FX-1* along with several dozen small satellites.

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.

December 22: Maiden launch of *Firefly Alpha* which will carry 26 minisats to orbit.

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>.

First Quarter of 2021: Launch on *Tianhe*, the first element of the Chinese space station.

January 3, 2021: Peak of Quadrantid meteor shower.

January 4, 2021: Second [uncrewed] orbital test flight of Boeing's *Starliner* spacecraft to the International Space Station.

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](https://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 2021: Launch of Amazônia-1, the first Earth observation satellite developed by Brazil.

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 4, 2021: The asteroid Vesta is at opposition. Vesta is the brightest asteroid and will get up to magnitude 6.2. Since the Moon isn't in the sky till midnight and Vesta will be high in the sky, it will be on the threshold of naked eye visibility, but more likely will require binoculars.

March 30, 2021: SpaceX's Dragon Crew-2 mission to the ISS.

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 1, 2021: Launch of three cosmonauts by Soyuz from Baikonur to the ISS.

April 17, 2021: Mars is 0.1 degrees north of Moon. This is an occultation in India, Indochina and western Indonesia.

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 4, 2021: Peak of the Eta Aquariid meteor shower.

May 17, 2021: Mercury is at greatest elongation, 22 degrees east of the Sun (hence is visible after sunset).

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 2021: First crewed flight of Boeing's *Starliner* space craft on a voyage to the Space Station.

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_\(rocket\)](https://en.wikipedia.org/wiki/Vulcan_(rocket)) and https://en.wikipedia.org/wiki/Astrobotic_Technology#Peregrine_lander.

July 4, 2021: Mercury is at greatest elongation, 21.6 degrees west of the Sun (hence can be seen before sunrise).

July 13, 2021: Conjunction of Mars and Venus. Venus will be half a degree north of Mars, the diameter of a Full Moon.

July 17, 2001: Pluto is at opposition.

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

July 27, 2021: Peak of Delta Aquariid meteor shower.

August 1, 2021: Mercury is in superior conjunction with the Sun.

August 1, 2021: Saturn is at opposition.

August 12, 2021: SpaceX's Dragon Crew 3 to the ISS.

August 12, 2021: Peak of Perseid Meteor shower.

August 19, 2021: Jupiter is at opposition.

September 13, 2021: Mercury is at greatest elongation, 26.8 degrees east of the Sun (hence can be seen after sunset).

September 14, 2021: First Dream Chaser cargo mission to the ISS.

September 14, 2021: Neptune is at opposition.

September 15, 2021: Launch of the IXPE X-Ray Telescope by Falcon 9. For more information, see <https://en.wikipedia.org/wiki/IXPE>.

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 7, 2021: Mars is in conjunction with the Sun.

October 9, 2021: Mercury is in inferior conjunction with the Sun.

October 11, 2021: The first Nova-C mission will carry the IM-1 lander and Moon Mark lunar rover to the Moon. To be launched by SpaceX.

October 16, 2021: Launch of Lucy, a mission to explore Jupiter's Trojan Asteroids. See [https://en.wikipedia.org/wiki/Lucy_\(spacecraft\)](https://en.wikipedia.org/wiki/Lucy_(spacecraft)) for details.

October 21, 2021: Peak of Orionid meteor shower.

October 24, 2021: Mercury is at greatest western elongation, 18 degrees west of the Sun (hence is visible before sunrise).

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.

November 4, 2021: Uranus is at opposition.

November 5, 2021: Peak of South Taurid meteor shower.

November 12, 2021: Peak of North Taurid meteor shower.

November 17, 2021: Peak of Leonid meteor shower (unfortunately coinciding with the Full Moon).

November 19, 2021: 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 28, 2021: Mercury is in superior conjunction with the Sun.

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

December 2021: First operational *Starliner* mission to the ISS.

December 4, 2021: Total eclipse of the Sun. Unfortunately, this one is only visible from West Antarctica and the ocean around it.

December 14, 2021: Peak of the Geminid meteor shower.

December 22, 2021: Peak of Ursid meteor shower.

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_\(spacecraft\)](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_\(spacecraft\)](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.

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Other Information

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

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

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A Chapter of the National Space Society
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Please enroll me as a member of Oklahoma Space Alliance. Enclosed is:

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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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