

OKLAHOMA SPACE ALLIANCE

OUTREACH –July 2019

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet
at Clifford and Claire McMurray's house
2715 Aspen Circle in Norman
2:00 p.m. on July 13, 2019
Directions are inside.

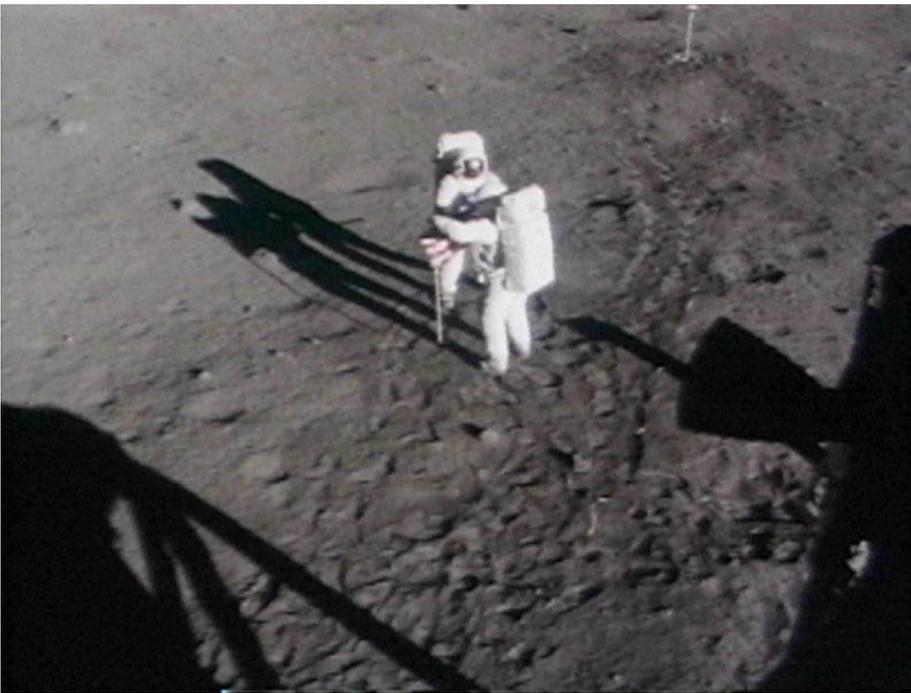


Figure 1 Armstrong and Aldrin set up US flag on the Moon (Apollo Archive)

OKLAHOMA SPACE ALLIANCE OUTREACH July 2019

July Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, July 13. at Claire and Clifford McMurray's house. Prospective members are also welcome. Their house is at 2715 Aspen Circle in Norman. An agenda is forthcoming.

To get to the meeting either: (1) Take the Lindsey Street east exit from I-35, turn right at Berry, and proceed to Imhoff Road. Turn right at Imhoff, right at Poplar Lane, left at Aspen Lane, and right at Aspen Circle. 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. p.m.

Saturday July 13, 2019 2:00 p.m.

Place: McMurray Residence

1. Introductions and review of Space events this past month
 - a. What's Happening in Space, News, Pictures, and Videos approximately one hour.
2. Break
 - . Oklahoma Space Alliance Chapter Business Discussion
 - a. Review OSA treasurer's report
 - b. Summary of June meeting minutes
 - c. July 20 event planning
 - d. Summary of July event planning meeting
 - e. Discuss proposal to sponsor an international sister chapter
3. Video: *Apollo 11* or ISDC video
4. Chat

***Apollo 11* Moon Landing 50th Anniversary Event:**

Oklahoma Space Alliance will be hosting a 50th Anniversary Commemoration of the *Apollo 11* Moon Landing at the Norman Public Library central location (225 N. Webster Ave.) from 1:30 p.m. – 5:00 p.m. on Saturday, July 20. We will also be commemorating the other Apollo missions as well as the Surveyor and Ranger missions and the Russian Moon missions, with information on more recent efforts. All are welcome and Admission is free. We will also have a cake for the celebration.

For more information, call Clifford McMurray, at 329-4326 (H) 863-6173 (C), or Syd Henderson at 365-8983.

Minutes of June Meeting

Oklahoma Space Alliance met the McMurrays' house in Norman, Oklahoma on June 15. In attendance were Clifford McMurray, Adam Hemphill, Mike Hopkins, John Northcutt, Tim Scott, Dave Sheely, Brian Swift, Steve and Karen Swift, and Syd Henderson. OSA President Clifford McMurray presided over the meeting. He also did an Update with links to the videos he presented. This can be found at <http://osa.nss.org/Update1906.pdf>, so I'll cover the highlights.

Congress put \$125 million in the budget at their own initiative (i.e. not requested by the President) for the development of nuclear thermal propulsion within NASA's space technology program. For more information, see <https://space-news.com/momentum-grows-for-nuclear-thermal-propulsion/>.

Is it better to use the water on Mars to generate fuel from water?

Astrobotic Development, one of the companies working on robotic technology for lunar missions, was one of contestants for the Lunar X-Prize but withdrew to have more time to develop a moon lander. We watched a video of Orbit Beyond interviewing their CEO.

We watched a video of Astrobotic Development. Their lander has very large egg-shaped propellant tanks with gold foil.

We watched a video by Intuitive Machines, another company working on moon landers for NASA.

We watched a video of Bridenstine. We will be sending men around the Moon again in 2022.

We watched a William Shatner narrated video advertising the Space Launch System. The title is "We Are Going" 36200

We watched several episodes of "This Week at NASA."

Kip observed that we were only 18 years behind the Russians in using out space resources for commercial users.

We watched SpaceX's launch of the RadarSAT constellation satellites for Canada.

There are 141 small launch companies competing for properties.

Business meeting: Our share for Meetup site is every six months. Voted to renew without comment. We currently have \$841.12 in Checking and \$267 in cash.

We watched a video of Eileen Collins talk at ISDC, where she got a Space Pioneer Award. She was the first the first female commander and first female pilot of a Space Shuttle. She noted that as you get older, it is easier going up to space and harder coming down.

--Minutes by OSA Secretary Syd Henderson

Notes on June 22 Planning Meeting

Cliff McMurray, Adam Hemphill, Mike Hopkins and Syd Henderson met at the McMurray residence on June 22 to help plan the Apollo 11 commemoration on July 20. We are going to do posters with information on the Apollo missions, and the Surveyor and Ranger mission before them, and the Russian's Luna and Lunik missions which included lunar rovers and sample returns.

We discussed advertising. Cliff has a contact at the Norman Transcript. Syd will contact the Oklahoma Gazette [done]. We will put up posters at all libraries in Norman system. We will allow a \$100 – 150 expenditure, which includes buying a sheet cake, which we wish to be 18 by 24 by 2 inches.

It would take three weeks to build a model.

Syd has Apollo 11 to bring to the commemoration.

We need posters to put up by July 1.

We watched the Mitchell Webb Moon Landing parody. This can be found at <https://www.youtube.com/watch?v=P6MOnehCOUw>.

--Notes by OSA Secretary Syd Henderson

Notes on July 7 Planning Meeting

Clifford McMurray, Adam Hemphill and Syd Henderson met at the McMurray resident on July 7. Mike Hopkins couldn't make it but sent copies of the posters for the meeting. Not all the posters need to go on the walls.

We need to put posters up at the Norman Public Libraries in Norman in the next three days. There are three of these: Norman Public Library central at 225 Webster Avenue, west at the old Borders book location, and east at 3051 Alameda St.

We will have an interview and two articles in the *Norman Transcript* and an event notification in the *Oklahoma Gazette*.

Kip will bring the Saturn V models

Syd will get plates, forks and cups.

We went through a discussion of what images to put on the cake. The cake is 24 by 18 by 2 images and costs \$45, with a few dollars more for an image.

--Notes by OSA Secretary Syd Henderson

Minutes of May Meeting

Oklahoma Space Alliance met at the McMurray resident in Norman, Oklahoma on May 11, 2019. In attendance were Clifford and Claire McMurray, Adam Hemphill, Mike Hopkins, Tom Koszoru, Cary Miller, John Northcutt, Tim Scott, Bryan Swift, Steve and Karen Swift, and Syd Henderson. This was Cary's first meeting. He is studying to be a biology teacher.

OSA President Clifford McMurray presided over the meeting. He also did an *Update* with links to the videos he presented. This can be found at <http://osa.nss.org/Update1905.pdf>, so I'll cover the highlights.

We watched the launch of a Falcon Heavy and the landing of the strap-on boosters.

The founder of Nanoracks will be at ISDC this year.

We watched the launch of the New Shepard 11 test flight, landing of rocket and capsule. This one carried 38 experiments to space on a suborbital flight.

Virgin Galactic is moving its operations to Spaceport America in New Mexico.

We watched a video on OSCaR, an autonomous mini-sat designed to clean up space debris. In the same vein, we watched a video on the new cube-shaped robot helpers on the ISS.

We watched a video on Blue Moon, a moon lander being developed by Blue Origin.

We watched a video on ways to deflect an asteroid, and one on a simulated deflection.

May 11 is the last day of the auction of Neil Armstrong's memorabilia. We watched a video on the auction and visited the website.

Christine Koch's stay on the ISS will be the longest stay in space by a female astronaut.

We watched a video of NASA Administrator Jim Bridenstine before Congress.

Business meeting:

We have \$893.89 in checking and \$267 in cash but had to pay \$118 for mailbox.

We discussed plans for the July 20 celebration of the 50th anniversary of the landing of *Apollo 11* on the Moon. Do we have a portable TV screen for showing videos? There will be too much light for a projector.

We will move the date of the June meeting to June 15 because ISDC and SoonerCon both fall on the weekend of the 8th.

There will be an Apollo 10 anniversary event at Weatherford High School Performing Arts Center on 7 May 19. Syd will post a link on Facebook.

--Minutes by OSA Secretary Syd Henderson

Space News

Astronomers are getting better at pinpointing the sources of fast radio bursts. The first of these, FRB 121102, has been observed for years since it repeats. It has been traced to a dwarf galaxy 3 billion light-years away and is thought to be a magnetar—i.e. a neutron star with an intense magnetic field.

Two more FRB sources have been pinned down in just the last two weeks, and unlike FRB 121102, these are not repeating and seem to be due to some other mechanism. FRB 180924 is in the outer regions of a massive old galaxy 3.6 billion light-years away, and, this galaxy no longer makes stars, let alone magnetars. FRB 190523 is located six billion miles away and is in a galaxy similar to the Milky Way. We now know where these are but have no idea what mechanism produced the.

FRBs typically emit a billion times as many radio waves as the Sun in a fraction of a second. It's worth to note that is as bright as a mobile phone ten meters away.

The Planetary Society's *LightSail 2* cubesat was launched on June 25 as one of the auxiliary payloads on a SpaceX Falcon Heavy rocket. *LightSail 2* was carried by vehicle named Prox-1 and released on July 2. It will unfurl to an area of 320 square feet. The entire satellite weighs eleven pounds. It contacted Earth on July 2, and began transmitting pictures on July 7.

The Planetary Society just launched a new "control panel" website for *LightSail 2* at www.planetary.org/explore/projects/lightsail-solar-sailing/lightsail-mission-control.html. When the sail is fully deployed, it should be visible from the ground, and this will give you sighting opportunities. I may not be able to give you long-term predictions for viewing *LightSail 2*, since the point of the mission is testing the use of light sails to change orbits.

NASA choose its next New Frontiers mission in late June. Dragonfly is an eight-rotor drone the size of the Curiosity Mars rover but designed to fly as well as land on the surface of Saturn's Moon Titan. The mission would be launched in 2026 and arrive at Titan in 2034. The mission will last two to seven years, exploring "sand" dunes where the dunes are made of organic chemicals (mostly methane), and the bottom of Selk Crater, an impact crater which melted water ice as well as methane ice.

Titan is the only satellite in the Solar System with a substantial atmosphere. Indeed, it is 50% denser than Earth, so a good place to fly a drone. The atmosphere is 94.2% nitrogen and 5.6%, with the rest being traces of higher hydrocarbons, hydrogen, argon, helium and oxides of carbon.

Dragonfly was chosen among 12 New Frontiers contestants, with the other finalist being the Comet Astrobiology Exploration Sample Return (CAESAR) to Comet 67P/Churyumov-Gerasimenko. Currently active New Frontiers missions are *Juno*, *New Horizons* and *OSIRIS-REx*.



Figure 2 Artist conception of Dragonfly at Titan (NASA JHU/APL)

Apollo Anniversary: *Apollo 11*

I've been recollecting the Apollo missions going back to Apollo 7, and you can find in the *Outreach* archives at <http://osa.nss.org/>. This month we finally get to the most famous of all the space flights, the *Apollo 11* mission that fulfilled Kennedy's promise and landed a man on the Moon before the end of the 1960s and returned him safely to Earth. Two men, actually. This one I remember watching with my father in our living room in Maine the summer before I went off to Maine. He was born seven years before Lindbergh's flight, and his father before the Wright brother's flight. It seemed likely at the time that I would live to see a man or woman on Mars, and, since he died in 2007, he might have too. He did get to see us send probes to the other planets in the Solar System, comets and asteroids, but also see manned flight limited to low-earth orbit for the last thirty-five years of his life.

It may not be remembered today, but then Vice-President Spiro Agnew (who is probably not remembered either), proposed going to Mars as the next step, and was shot down. President Nixon would eventually cut down on the number of Apollo missions, partly because they were becoming less popular, and partly because they were the legacy of his rival, President Kennedy. Instead, he committed himself to the development of the Space Shuttle. The head of the NASA Office of Manned Space Flight, George Mueller announced the plan for a reusable shuttle on August 10, 1968 and Nixon approved it in 1972. (The Saturn V's that was originally to carry *Apollo 18* was rededicated to launch *Skylab*, America's first space station, in 1973, so that is also part of Nixon's space legacy. The two that were to launch *Apollo 19* and *20* were never used.

Neil Armstrong was 38 years old at the time of the *Apollo 11* mission. (He turned 39 two years later.) Armstrong was a navy pilot, making his first solo flight at the age of 19, and flew 78 missions during the Korean War. He flew over 200 hundred different models of airplane, including flying six times in the X-15, eventually reaching at altitude of 40 miles on a flight in 1962.

When the first astronauts were chosen, he was ineligible since he was a civilian pilot by that time, but he did qualify for Project Gemini, and made his first space flight in March 1966 with David Scott aboard *Gemini 8*. This was the first spacecraft to achieve a docking in space and had a failure that caused the spacecraft to spin and almost killed the astronauts. Armstrong was backup command pilot for *Gemini 11*. The Command Pilot for that mission was Pete Conrad, who would become the third man to walk on the Moon.

Edwin “Buzz” Aldrin was 39 at the time of *Apollo 11*. He was a jet fighter pilot during the Korean War and flew sixty-six missions. He also got a doctoral degree in astronautics from MIT, and was the first astronaut with a doctoral degree. His first flight was aboard *Gemini 12* in November 1966. His crewmate for that flight was James Lovell, who would later fly around the Moon twice, aboard *Apollo 8* and *Apollo 13*.

Gemini 12 was the last mission in the Gemini program, during which Buzz Aldrin made three EVAs, and the spacecraft once again achieved a docking. One of the purposes of this mission was to show that astronauts could work effectively outside a spacecraft.

Michael Collins was thirty-eight at the time of *Apollo 11*, turning 39 that Halloween. (All three *Apollo 11* astronauts were born in 1930.) His first spaceflight was *Gemini 10* along with future moonwalker John Young. Collins began flight training in August 1952 but never served in the Korean War probably because he was training as a fighter pilot at the time the war ended. In 1960, he became a test pilot. By the time he was finally accepted to the astronaut pool, he had flown 2700 hours in jet aircraft. On this mission, *Gemini 10* rendezvoused with two Agena target craft, docking with one of them. Collins later performed a spacewalk to the other.

Collins was supposed to be on *Apollo 9* (the mission which, due to a swap, became *Apollo 8*), but discovered he had a herniated disc, and the rehab time took him off that flight and put him aboard *Apollo 11*.

So, for all three astronauts, this was their second mission, and it was the last for all three. Collins was offered a chance to fly on *Apollo 14* and *Apollo 17*, but decided the strain was too much for his family and retired without a chance to become a moonwalker.

This is such a famous flight and is being commemorated in pretty much any space-rated magazine, that I’m hesitant to go into great detail. *Apollo 11* launched at 9:32 a.m. EDT on July 16, 1969. One and a half hours later it headed for the Moon, where it entered orbit around 1:21 p.m. on July 19. Twenty-four hours later, the LEM separated from the Command Module. After the whimsical names of *Charlie Brown* and *Snoopy* given to the *Apollo 10* command module and LEM, NASA wanted more sober names for *Apollo 11*, and *Columbia* and *Eagle* were given to the corresponding crafts.

From separation to landing took four-and-a-half hours, and a bit of alarm when it was discovered that the projected landing spot was strewn with boulders, and Armstrong maneuvered the lander to an apparently clear spot which turned out to have a crater so had to pass a few feet beyond that to land. The first words from the Moon were “Houston—Tranquility Base Here, the *Eagle* has landed. The time was 6:17 p.m. EDT on July 20, 1969. At 10:56 p.m. EDT Neil Armstrong became the first person to set foot on the Moon, saying “That’s one small step for a man, one giant leap for mankind.” (I don’t know what Aldrin’s first words were when he followed Armstrong to the surface.) The two moonwalkers were on the surface for two and a half hours, gathering rocks, laying out experiments and setting up a flag and a plaque. They left the Moon at 3:54 p.m. EDT on July 21.

Most of the photographs you see on the Moon were of Aldrin since Armstrong photographed him, but not the other way around. However, the LEM itself carried external cameras which did show both astronauts, and you can see these in the excellent documentary *Apollo 11*. The Command Module also had cameras, so you see extraordinary split screen video of the Command Module and LEM approaching each other as they prepare to come home.

The astronauts left lunar orbit at 12:56 a.m. on July 22, by which time the Command module had orbited the Moon 30 times with Collins being by himself most of that time. Earth landing was 4:50 EDT on July 24.

There are many books and films about the *Apollo 11* mission, including *Apollo 11*, *In the Shadow of the Moon*, *First Man*, *Moon Shot*. Collins has written several books, including his autobiography, *Carrying the Fire*. Aldrin has co-written two autobiographies, *Reaching for the Moon* and *Magnificent Desolation*. The latter mostly concentrates on his life after *Apollo 11*. As near as I can tell, Neil Armstrong never wrote an autobiography, though there have been several books about him, including the official biography *First Man: the Life of Neil Armstrong* by James Hansen..

Sky Viewing

The most prominent meteor and only famous shower over the next couple of months are the **Perseids**, which peak on the night of August 12-13. Unfortunately, this year’s peak is near the full Moon, which occurs on August 15, which will drown out a lot of the meteors. Fortunately, lots of meteors will be visible in the weeks before the peak, especially in the period August 9 – 14, so you’ll have a good chance to see some. Maximum number of meteors visible is about sixty

per hour. The radiant (the point that the meteors appear to come from) is in Perseus, which is high in the sky around 3:00 a.m.

Less prominent are **Southern Delta Aquariids**, which do have the advantage this year of peaking around the new Moon and produce about sixteen meteors per hour. The radiant is sixteen degrees south of the celestial equator, which is not as good as that of the Perseids. There are also the Northern Delta Aquariids, which peak about mid-August, which mean they are also dealing with the full Moon and are not very prominent in the best of times. Their radiant is almost exactly on the Celestial Equator.

Mercury is currently lost in the Sun, but will become visible in early August when it rises an hour before the Sun. By August 9, it will be at greatest elongation and magnitude 0, and will continue to brighten for a week after that, after which it will get lost in twilight.

Venus is nearing its August 13 superior conjunction with the Sun and is barely visible with binoculars just before sunrise. Unless you have clear eastern horizon, you won't be able to see it until September.

Mars has disappeared into the sunset as it approaches conjunction with the Sun. It will reappear in mid-October.

Jupiter is south by southeast at sunset and is visible and bright (magnitude -2.4) for the rest of the evening. The two bright stars to the west of it are Antares and Dschubba (alpha and delta Scorpii), although Jupiter itself is in the southern part of the constellation Ophiuchus. Jupiter remains there through August while it is in retrograde motion, but will start heading toward Sagittarius, though it won't reach that constellation until November.

Saturn was at opposition on July 9 and is in Sagittarius about three fist-widths east of Jupiter. At magnitude 0.1, it is nowhere near as bright as Jupiter, but is much brighter than any stars in the vicinity. It's also in retrograde motion and will be in Sagittarius for quite a while.

Uranus is in the southern part of Aries about ten degrees south of Hamal (alpha Arietis), which, at magnitude 2.01, is pretty conspicuous for a mostly dim constellation. Uranus doesn't move rapidly against the stars in any case, and since it is stationary on August 11 in preparation for its October opposition, it will remain approximately in this spot through the end of August.

Neptune is nearing a September 10th opposition, which means it is visible through binoculars if you want to search for a magnitude 7.9 planet. It's still in Aquarius and will be for years.

Sky & Telescope has finder charts online for Uranus and Neptune through the rest of 2019 and early 2020. The URL is <https://s22380.pcdn.co/wp-content/uploads/UrNep-2019-2020.pdf>

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

Viewing Opportunities for Satellites (July 13 – August 13)

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.

<https://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/JavaSSOP/JavaSSOP.html> 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. It doesn't give you information for Tiangong 2, so I'm using Heavens Above for those. The *Sky & Telescope* web site carries ISS observation times for the next few nights at skyandtelescope.com/observing/almanac.

With the addition of the solar panels, the International Space Station can be as bright as magnitude -3.8, which it will on March 18, 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, although, since it is lower in the sky, it is more difficult to see. Tiangong 2 which can get up to magnitude 1.0 at least.

Missions to and from the International Space can change its orbit. There are two launches to the ISS during July, the Expedition launch from Baikonur on July 20, and a Space X Cargo mission on July 21.

ISS, 15 July 2019

Time	Position	Elevation
11:03 p.m.	255°	20°
11:04	267	34

11:05	322	46
11:06	10	34
11:07	28	20

ISS, 16 July 2019

Time	Position	Elevation
10:14 p.m.	226°	22°
10:15	225	42
10:16	342	88
10:17	49	43
10:18	48	23

ISS, 17 July 2019

Time	Position	Elevation
9:25 p.m.	197°	19°
9:26	178	31
9:27	134	42
9:28	89	31
9:29	70	19

ISS, 18 July 2019

Time	Position	Elevation
5:33 a.m.	296°	20°
5:34	280	36
5:35	226	53
5:36	171	36
5:37	155	20

ISS, 19 July 2019

Time	Position	Elevation
4:43 a.m.	318°	21°
4:44	326	41
4:45	34	75
4:46	116	41
4:47	147	22

ISS, 19 July 2019

Time	Position	Elevation
9:23 p.m.	248°	21°
9:24	263	37
9:25	321	56
9:26	17	37
9:27	37	21

Tiangong 2, 21 July 2019

Time	Position	Elevation
9:33 p.m.	305°	10°
9:36	23	51
9:39	98	15

Vanishes into Earth's Shadow

Tiangong 2, 23 July 2019

Time	Position	Elevation
9:09 p.m.	297°	10°
9:12	228	90
9:15	118	10

HST, August 1, 2019

Time	Position	Elevation
6:04 a.m.	229°	20°
6:05	210	27
6:06	182	31
6:07	155	27
6:08	137	20

HST, August 2, 2019

Time	Position	Elevation
5:54 a.m.	231°	20°
5:55	212	26
5:56	186	30
5:57	159	26
5:58	140	20

HST, August 3, 2019

Time	Position	Elevation
5:43 a.m.	232°	19°
5:44	214	25
5:45	188	28
5:46	140	20

ISS, August 5, 2019

Time	Position	Elevation
9:58 p.m.	304°	22°
9:59	295	41°
10:00	223	70
10:01	153	41

Vanishes into Earth's shadow

ISS, August 6, 2019

Time	Position	Elevation
9:09 p.m.	326°	21°
9:10	341	38
9:11	39	57
9:12	98	38
9:13	114	21

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, the ISS at 9:59 p.m. on August 5, measure two-and-a-half fist-widths north 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:

July 20: Launch coverage for Expedition 60/61 to the ISS begins at 10:30 a.m. with actual launch at 11:28 a.m. Docking coverage begins at 5:00 p.m. with docking at 5:50 p.m. Hatch opening and welcoming ceremony coverage begins at 7:00 p.m. with hatch opening about 7:50 p.m. Replay of Apollo 11 moonwalk coverage at 9:00 p.m.

July 21: Coverage of SpaceX CRS-18 cargo launch to the ISS, 6:00 p.m.

July 31: Coverage of launch of Progress 73 cargo craft to ISS begins at 6:45 a.m. with actual launch at 7:10 a.m. Rendezvous and docking coverage begins at 9:45 a.m. with actual docking at 10:35 a.m.

Calendar of Events

July 12: Oklahoma City Astronomy Club meets in Nielson Hall room 170 at Oklahoma University. 7:30 p.m. After the meeting, they will move to Linn Hall immediately south of Nielson and visit the new OU Observatory on top of Linn Hall. Nielson Hall is on the south side of Brooks a couple of buildings east of Elm Avenue. See <http://www.ok-castroclub.com/> for details.

July 13: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

July 15: launch of *Chandrayaan-2* from Satish Dhawan Space Center, Mission includes a lunar orbiter, lander and rover. For more information, visit <https://www.isro.gov.in/chandrayaan2-home> or <https://en.wikipedia.org/wiki/Chandrayaan-2>.

July 20: 50th Anniversary of *Apollo 11* landing on the Moon.

July 20, 11:28 a.m.: Launch of the Expedition 60 crew from Baikonur. This is the last scheduled Soyuz with a seat contracted by NASA.

July 21, 6:35 p.m.: Launch of SpaceX CRS-18 cargo mission to the ISS.

August 9: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.

August 10: Mercury is at greatest western elongation, 19 degrees from the Sun (hence is visible before sunrise.)

August 10: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

August 12: Peak of the Perseid meteor shower.

August 13: Venus is at superior conjunction with the Sun.

September: Arrival of *OSIRIS-REx* at the near-earth asteroid 101955 Bennu to return samples. For more information, visit <http://en.wikipedia.org/wiki/OSIRIS-REx> or <http://science.nasa.gov/missions/osiris-rex/>.

September 6: Landing of *Chandrayaan-2* lander and rover on the Moon. (see July 15)

September 9: Neptune is at opposition.

September 13: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.

September 14: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

September 17: Boeing's CST-Starliner makes its first (uncrewed) flight to the ISS. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

September 25: Expedition 61 Launch from Baikonur, Kazakhstan to the ISS.

October 3: Return of ISS Expedition 60 at Baikonur Cosmodrome in Kazakhstan.

October 11: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.

October 12: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

October 15: Launch of *CHEOPS*, the European Space Agency's exoplanet studier, from Kourou, French Guiana by a Soyuz rocket.

October 19: Mercury is at greatest eastern elongation, 25 degrees from the Sun (hence is visible after sunset.)

October 28: Uranus is at opposition.

November 8: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.

November 9: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

November 11: Mercury transits the Sun. The transit pretty much lasts all morning.

November 15: Crewed flight of Dragon 2 to the ISS. If this goes as scheduled, it will be the first manned orbital launch by the US in eight years.

November 28: Mercury is at greatest western elongation, 20 degrees from the Sun (hence is visible before sunrise.)

November 30: Boeing's CST-Starliner makes its first crewed flight to the ISS. See https://en.wikipedia.org/wiki/CST-100_Starliner for details. Either this or the July SpaceX mission will be the first manned orbital flight for an American spacecraft since July 2011.

December: Launch of China's *Chang'e 5* lunar sample return mission. This will be the first such mission since 1976.

December 13: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.

December 14: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

December 14: Peak of the Geminid meteor shower.

December 26: Annular solar eclipse visible in Saudi Arabia, Qatar, India, Sri Lanka, Indonesia, the Philippines and Guam.

Late 2019: Launch of the Lunar Scout mission to the South Pole of the Moon. This includes a lunar lander, an optical telescope, and a laser reflector.

Early 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>.

February 6, 2020: Launch from Cape Canaveral of the European Space Agency/NASA Solar Orbiter (SolO), which will orbit the Sun at a distance closer than Mercury. Not to be confused with NASA's *Parker Solar Probe*. Web site is sci.esa.int/solarorbiter

March 24, 2020: Venus is in greatest eastern elongation, 46 degrees from the Sun (hence is visible after sunset.)

May 2020: First operational mission of Crew Dragon.

June 2020: [Moved from 2019] Maiden flight of the Space Launch System.

June 2020: Launch of Japan's OMOTENASHI cubesat lunar lander.

June 2020: NASA launches the Lunar IceCube, Lunar Polar Hydrogen Mapper, and Lunar Flashlight lunar orbiters. For more information, see https://en.wikipedia.org/wiki/Lunar_IceCube.

July 2020: United Arab Emirates launch the Mars probe *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 2020: Launch of the *Mars 2020* space rover, which will arrive on Mars at the beginning of 2021. For more information, see https://en.wikipedia.org/wiki/Mars_2020 or <https://mars.jpl.nasa.gov/mars2020/>.

July 16, 2020: Maiden flight of Ariane 6 from Kourou, French Guiana.

July 23, 2020: Launch of 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 25, 2020: ESA launches the *ExoMars Mars Rover*, which has been christened *Rosalind Franklin*. For more information, visit en.wikipedia.org/wiki/Exomars.

August 13, 2020: Venus is in greatest western elongation 45 degrees from the Sun (hence is visible before sunrise.)

October 13, 2020: Mars is at opposition, 39 million miles from Earth.

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.

December 21, 2020: Great conjunction between Jupiter and Saturn. The two planets will be separated by six minutes of arc.

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

Sometime in 2021: The *ExoMars* Mars landers land on Mars. These in the Russian Kazachok surface platform and the ESA's *Rosalind Franklin* Mars rover.

Sometime in 2021: India hopes to launch its first manned spaceflight, but 2024 is more likely.

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

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

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

Sometime in 2022: Proposed launch date of JUICE, the Jupiter Icy Moon Explorer, by the European Space Agency. The JUICE web site is <http://sci.esa.int/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 <http://sci.esa.int/euclid>.

Sometime in 2023: *OSIRIS-REx* returns with samples from the Asteroid Benu.

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.

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>.

December 2025: *BepiColombo* arrives at Mercury orbit.

Sometime in 2030: JUICE achieves Jupiter orbit. [See 2022.]

Sometime in 2033: JUICE achieves Ganymede orbit. [See 2022.]

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, 2019 (Area Code 405)

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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]

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

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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.

Do you want to be on the Political Action Network?

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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.**