

OKLAHOMA SPACE ALLIANCE

OUTREACH – May 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 May 11, 2019
Directions are inside.



LEM *Snoopy* returning to Charlie Brown (NASA)

OKLAHOMA SPACE ALLIANCE OUTREACH May 2019

May Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, May 11. 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.

**Saturday May 11, 2019
Tentative Program
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 April meeting minutes
 - c. Summary of July event planning meeting
 - d. Discuss proposal to sponsor an international sister chapter
3. Video: *The Red Stuff*, a video of the early Russian space program.
4. Chat

Minutes of April Meeting

Oklahoma Space Alliance met the McMurrays' house in Norman, Oklahoma on April 13. In attendance were Clifford and Claire McMurray, Russ Davoren, Adam Hemphill, Mike Hopkins, Dave Sheely, Bhagyashree Waghule, 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/Update1904.pdf>, so I'll cover the highlights.

We watched a video of the Indian anti-satellite mission. This launched a projectile that destroyed a moribund low-orbiting satellite, creating a field of potentially hazardous debris. Most of the debris will burn up in Earth's atmosphere over the next few months, but some pieces were propelled higher than the Space Station's orbit, and there's always a possibility one of the pieces may hit another satellite, creating a cascade effect as in the movie *Gravity*. However, odds of a collision are small, but other nations are upset.

There was a test destruction of a satellite by China in 2007, and of the 3000 tracked pieces of debris from that, only 616 have burnt up. However, that was in a higher orbit. 400 pieces have been identified from the Indian satellite, of which 60 are greater than ten centimeters (four inches) in diameter. 24 of these 60 went higher than the orbit of the ISS. The risk of ISS being struck by space debris went up by an estimated 44% over the ten days after the Indian satellite's destruction.

The astronauts from last October's aborted Soyuz launch are now aboard the Space Station. We watched a video of the successful launch.

The Bering Strait meteor hit the atmosphere with a velocity of 71,600 miles per hour, which is about three times escape velocity from Earth (and slightly greater than Earth's velocity around the Sun).

The asteroid Bennu has hydrated clay and contains magnetite. Bennu's surface is covered with boulders and the areas available for landing spacecraft are much smaller than projected.

We watched a video of Ian Anderson and Cody Coleman playing a duet, with Coleman in space. (Adam was skeptical that this could have been done live.)

We watched a video of a Neil Armstrong interview from 2011. Armstrong flew more than 70 missions during the Korean War.

What are we doing to commemorate the 50th anniversary of the Apollo 11 moon landing? We can try to get the big room at the Norman Library, bring a big cake. Advertising can include posters and possibly an invitation to the Norman Astronomy Club.

We will have a brainstorming meeting on April 27 at 2:00 p.m.

--Minutes by OSA Secretary Syd Henderson

Yuri's Night

After the April meeting, Claire, Clifford, Mike and Syd stayed to celebrate Yuri's Night. (Yuri's Night is April 12, but we waited to the meeting.) We watched a documentary, *Starman*, on Yuri Gagarin and part of *The Red Stuff*, a documentary on the early history of the Russian space program. Plan is to watch the rest of *The Red Stuff* at a future meeting. I believe *Starman* was included as an extra on the disk, but it's a solid documentary.

Notes on Celebration of Moon Landing

These are copied from Adam's notes of our April 27 brainstorming session:

Apollo 11:
The First Lunar Adventure
What's Happened Since?
An Earth-Moon Economy?

NOTE Claire would like to put the 3 subheads beside the larger main head. Also, put faded Earthrise photo in background

Event Focus

- Future of the Earth-Moon and the NSS Roadmap
- The Earth-Moon economy(?)
- **Still need to determine our particular draw**

Advertising:

- OKC Astro club(?)
 - Conflicting events, but might work for advertising
- Posters(?)
 - At least at the library we're doing the event
 - The Norman Transcript (advertisement)
 - Oklahoma Gazette (207,164 central OK readers read it at least once per month.)
 - Universities (which departments and where?)
- Meetup site
- Facebook page
- OU radio (needs at least 2 weeks' notice)
 - KROU and KGOU
- University of Central Oklahoma
 - KOCU

Location

- Glass room at Norman Central Library
- For questions, best person to talk to is Annette, who generally works Monday-Friday

- Reserved for Noon-5pm
 - Plan on no more than 15 minutes for set-up, and we can ask if we need look like we'll need more time. [Claire--If we're putting up lots of posters, a TV, handouts, & serving cake, we'll need at least an hour. **Can we get it? If not, run from 2-4 pm.**
 - Chairs? We will need folding chairs--can library provide?
 - Tables--We will need: can library provide several?
 - Tear-down must be done by 5
- Facilities: One wall for posters
 - We can provide the projector
 - Internet access available
 - We need to be sure that the wall will be available for posters
- Possibly bring in a TV for background video streaming?
 - Maybe SpaceX landings on loop
 - Tesla Roadster video(?)
 - Maybe include Claire's Roadmap Ppt, revised
 - use actual Roadmap milestones (see brochure) (and only NSS pictures ?)
 - Parts I-III only?
 - Omit some of my intro material

Posters in library:

- One per program for other programs
 - LRO imagery of Apollo 11
 - Surveyor
 - Ranger
 - Russian Rover program (Lunakhod)
 - China's Program
 - SpaceIL
 - Poster for India's program
 - Poster for Japan's program
 - Poster for future commercial (robotic) landers
 - Poster for future human landers
- One per landing (at least for Apollo)
- Future
- Far future

[Claire's Note--too many posters cause visual clutter--folks quit looking]

Items for event

- Look at 3D Printing some items (useful for discussions)
 - Apollo capsule
 - Lander (if possible)
 - Orion
 - Starship (two stage, for comparing mission architectures)
- Videos as well
 - Good for prompting questions
- Possible presentations
 - Future
 - SpaceX
 - NASA
 - China
 - Blue Origin (Blue Moon)
 - New Armstrong
 - Xeus (Masten Aerospace)
 - Propellant manufacturing
 - Dear Moon (artists to the Moon)

- Moon Village (ESA)
- Present
 - SpaceIL
 - Chang'e landers, and China in general
 - Other X-Prize people
- Past
 - Apollo
 - Ranger
 - Surveyor
 - The Russian program
 -

Handouts

- “For more information, see”
- Ad Astra Settlement Roadmap [**Claire’s note: these are expensive, and quantity is limited. Consider using my Roadmap brochure instead. It includes Roadmap URL, we can DISPLAY a copy of Roadmap (flat, taped down).**]

Apollo Anniversary: *Apollo10*

Apollo 10 was the penultimate Apollo mission before the *Apollo 11* Moon landing and was essentially a dress rehearsal for that mission. As such, it tends to get overshadowed by that mission and the *Apollo 8* mission, which was the first to leave Earth orbit and included the famous Christmas Eve broadcast. The astronauts on this mission were John Young, Thomas Stafford, and Eugene Cernan. The command module was named *Charlie Brown* and the lunar module *Snoopy*. (After this mission, NASA insisted that astronauts choose more serious—and boring—call signs. Thus we never got to hear an astronaut say “The Beagle Has Landed.” However, on *Apollo 16*, the command module was *Casper* as in Casper the Friendly Ghost.)

Young, Stafford and Cernan are among the most accomplished of astronauts. Commander Tom Stafford flew on *Gemini 6A* and *Gemini 9A* and would be the commander of the *Apollo Soyuz* mission. On this last mission he became the first general to fly into space. On this mission, he and Lunar Module Pilot Eugene Cernan descended within 8 miles of the lunar surface. Since Stafford never got to land on the Moon, he has the odd distinction of being the man who came closest to the Moon without actually walking on it. The Stafford Museum in Weatherford, Oklahoma is named for him.

John Young was one of the two crew members of *Gemini 3*, the first crewed Gemini mission, in 1962. (Gus Grissom was the other crew member.) He flew on *Gemini 10* with Michael Collins. On that flight, *Gemini 10* docked twice with Agena target vehicles. On this flight, he was commander of *Apollo 16* and accompanied Lunar Module pilot Charles Duke to the surface of the Moon. In 1981 he famously commanded the first orbital Space Shuttle flight, and commanded a shuttle flight in 1983, giving him six spaceflights aboard seven vehicles. He was also supposed to command the mission that launched the Hubble Space Telescope but lost his chance when the *Challenger* exploded and delayed the mission several years. (He was critical of NASA in the wake of the *Challenger* explosion, and rumor is that is why he was dropped from the later flight.)

Lunar Module Pilot Gene Cernan was pilot of *Gemini 9A* (flying with Tom Stafford), and as commander of *Apollo 17*, became the most last person to date to walk on the Moon. (Since on the first spacewalk Harrison Schmitt left the LEM after Cernan, Schmitt was the last person to date to set foot on the Moon for the first time.)

Apollo 10 was launched at 12:49 EDT on May 18, 1969 and entered lunar orbit on May 21. On this expedition, the Moon was near apogee, so when the astronauts were on the far side of the Moon at the same time Houston was on the side of the Earth away from the Moon, they were 220,820 nautical miles (254,361 statute miles) from home, the farthest anybody has ever been from home.

At 7:01 p.m. on May 22, the LEM separated from the Command Module, beginning eight hours and ten minutes of orbiting the Moon, descending to within 47,000 feet of the lunar surface. Stafford and Cernan completed four orbits of the Moon while in the LEM. The command module orbited the Moon 31 times in 61.5 hours. *Apollo 10* left lunar orbit on the morning of May 24. On its return it set the all-time speed record for a manned space mission.



Apollo 10 Astronauts: Cernan, Stafford and Young. (Wikipedia)

One of the purposes of this mission was to scout out possible landing sites, and they twice flew over the future *Apollo 11* landing site at low attitude.

Could *Apollo 10*'s LEM crew have defied orders and landed on the Moon? Actually, yes, the question is rather could they have landed and taken off again, and that's more doubtful. Some reports say they didn't have enough fuel to do it, and others that it would have been at the very margin of achieving it. However, given that at one point during lunar orbit the LEM went into a spin and the crew had to burn fuel to correct it, they would have lost their lives if they had tried.

Incidentally, when *Snoopy* was released from *Charlie Brown*, the LEM was placed in heliocentric orbit. Now the *Apollo 9* LEM, *Spider*, re-entered the Earth's atmosphere in 1981 and the *Apollo 13* LEM, *Aquarius*, burnt in right after the crew jettisoned. All the LEMs which landed on the Moon were crashed into the Moon so seismometers could study the lunar interior. This means *Snoopy* is the only surviving lunar ascent stage in space. It's been lost since 1969, but according to this article, it may have been spotted last week: <https://mysteriousuniverse.org/2019/05/trashed-21/>.

If this is correct, Tom Stafford would know the location *Snoopy* fifty years after it was jettisoned. He's 88 and still alive. John Young died on January 5, 2018 at the age of 87, and Eugene Cernan on January 16, 2017 at the age of 82.

Space News

On April 20, SpaceX experienced a bump on its road to manned spaceflight when one of its two Crew Dragon capsules exploded during a static fire test. This was the capsule that was supposed to conduct the In-Flight Abort Test in June, so now the other Crew Dragon capsule will have to do that, which means in turn that the first SpaceX manned flight test, still booked for July, will probably be delayed until the beginning of 2020.

On the bright side, the testing of the Draco thrusters on the same day was successful, and on May 4, SpaceX successfully launched a ISS resupply mission and on April 11 launched its second Falcon Heavy.

In early April the scientists with the Event Horizon Telescope release the first-ever picture of a black hole, which gained a great deal of attention as it was the first ever image of an object which many had doubted would ever be seen (and some scientists keep trying to show does not exist).

A word of caution when viewing the famous image of the giant black hole in M87: this is actually a composite radio image of the accretion disk surrounding the black hole, since the hole itself does not emit light, and it is a false-color image showing the event horizon as a black circle. The image was constructed using a technique called very long baseline interferometry, which allows images from widely separated radio telescopes to be merged into one. In this case, it was eight telescopes around the world, and the computation demands were ferocious. The images were taken over four days, but it took two years to get the picture.

The team is also attempting to image Sagittarius A, the black hole at the center of the Milky Way. This black hole is only a thousandth of the mass of that in M87, which by the laws governing black holes is a thousandth of its diameter, but it's also obviously a lot closer.

For a detailed article, see <https://aasnova.org/2019/04/10/first-images-of-a-black-hole-from-the-event-horizon-telescope/>,

Only one month into their current observing run, LIGO has detected five possible gravitational wave events, three of which are pairs of black holes colliding, one two neutron stars colliding, and, for the first time, a possible collision of a black hole with a neutron star. The signal from this event was weak so it and one of the black hole collisions may be spurious, but the other three collisions look to be genuine.

Meanwhile, in addition to finding candidates for exoplanets, NASA's Gaia spacecraft has detected over 14000 asteroids, including some well out of the plane of the ecliptic.

Sky Viewing

Information for this section comes from the March and April issues of *Sky & Telescope* and *Astronomy*, and from their websites.

Mercury is currently lost in the glare of the Sun, but will have a good elongation later in the month, setting an hour after the Sun and shining at magnitude 1.0. It will fade by mid-June to magnitude 0.1, but will have a close conjunction with Mars, with only a quarter of a degree separating them. The conjunction lasts a couple of days. Mercury will reach greatest elongation on June 23 but is brighter early in the month.

Venus is just visible before dawn both in May and June. Although it is still magnitude -3.8, it is only visible for maybe half an hour before sunrise.

Mars is getting low in the west after sunset (which is why it's able to have a conjunction with Mercury). At the moment, it is between the horns of Taurus the Bull, but at magnitude 1.7 is fainter than Aldebaran. In June, it will be moving into Gemini where it will be outshone by Pollux. Interestingly, Mercury will be on the near side of the Sun while Mars is on the far side. In fact, in a telescope, Mercury will appear larger than Mars.

Jupiter is getting ready to put on a show. It's currently rising around 11 p.m., but that will be around 9 p.m. on May 31, and by the time it reaches opposition on June 10, it will be shining all night long at magnitude -2.6. It's located in the lower, faint part of Ophiuchus not far from the northern part of Scorpius. This is the brightest Jupiter has been in five years, but it's also the lowest opposition in a while. Just like the Sun reaches its highest point of the year on June 21, the ecliptic reaches its lowest point 12 hours later (at 1:00 a.m. due to Daylight Saving Time), so planets at opposition near that date will be as low in the sky as the Sun in December.

Saturn is rising about 1:00 a.m. and is three fist-widths east of Jupiter. It is also magnitude 0.4 and is in Sagittarius. In fact, Saturn is about two hours behind Jupiter and will be at opposition on July 8.

Uranus is just past conjunction with the Sun and won't be visible even through binoculars until early June. At that time, it will be about ten degrees south of Alpha Arietis, which is magnitude 2.0, and about the same distance north of Alpha Piscium, which is only magnitude 3.8. Aries is a mostly dim constellation, especially in the area where Uranus is hiding, and Pisces is dim throughout.

Neptune is rising just before twilight, but by the middle of June will be rising at 1:00 a.m. which will make it possible to find it with binoculars. However, there are few good stars to guide you to it.

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>

The most prominent meteor shower in the next couple of months is the **Arietids**, which peak on June 7, but really last a couple of weeks, peaking at about 60 asteroids per hours. The catch is that the radiant is Aries, which you may have noticed is where Uranus is currently and is not visible. The Arietids peak right before dawn and tend to be drowned out by twilight.

Technically, there is a second shower, the Zeta Perseids, which peak at the same time, is also drowned out by sunlight, and is so inconspicuous that it was first detected by radio astronomers.

Finally, there are the Eta Aquarids, which peaked on May 5, but has a broad peak, so you may be able to see some even now. This can get up to 40 meteors per hour in the Southern Hemisphere, but you can see some in the Northern Hemisphere as well. This shower is one of two originating from Halley's Comet, the other being the more prolific Oriionids, which peak in October.

Viewing Opportunities for Satellites (May 11 – June 11)

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. SpaceX launched a cargo mission to the ISS on May 4. There will be a Progress cargo launch on June 5. Outside of those, there are no missions to the ISS until July, and the next return mission is June 24. China appears to have discontinued missions to Tiangong 2,

HST, 13 May 2019

Time	Position	Elevation
9:33 p.m.	224°	20°
9:34	206	28
9:35	178	31
9:35:57	150	28
9:36:30	139	24

Vanishes into Earth's shadow

HST, 14 May 2019

Time	Position	Elevation
9:22 p.m.	227°	20°
9:23	209	28
9:24	180	32
9:25	152	28
9:26	133	20

Tiangong 2, 15 May 2019

Time	Position	Elevation
5:42 a.m.	293°	10°
5:45	210	66
5:48	127	10

HST, 15 May 2019

Time	Position	Elevation
9:12 p.m.	229°	20°
9:13	210	27
9:14	183	31
9:15	155	27
9:16	136	20

Tiangong 2, 16 May 2019

Time	Position	Elevation
Appears from Earth's shadow		
4:43 a.m.	311°	28°
4:44	25	64
4:45	108	10

HST, 16 May 2019

Time	Position	Elevation
9:01 p.m.	231°	20°
9:02	212	26
9:03	185	30
9:04	158	26
9:05	140	20

ISS, 18 May 2019

Time	Position	Elevation
5:23 a.m.	315°	22°
5:24	318	43
5:25	55	84
5:26	126	42
5:27	130	22

ISS, 18 May 2019

Time	Position	Elevation
10:01 p.m.	251°	20°
10:02	280	42
10:03	344	51
Vanishes into Earth's shadow		

ISS, 19 May 2019

Time	Position	Elevation
9:10 p.m.		
	220°	22°
9:11	215	41
9:12	139	77
9:13	59	41
9:14	53	22

Tiangong 2, 19 May 2019

Time	Position	Elevation
9:27 p.m.	227°	10°
9:30	149	53
9:33	71	10

Tiangong 2, 21 May 2019

Time	Position	Elevation
9:03 p.m.	246°	10°
9:07	332	79
9:10	61	10

ISS, 21 May 2019

Time	Position	Elevation
9:05 p.m.	264°	18°
9:06	284	28
9:07	323	36
9:08	2	28
9:09	22	18

Tiangong 2, 1 June 2019

Time	Position	Elevation
9:21 p.m.	296°	10°
9:24	210	81
9:27	122	13

ISS, 6 June 2019

Time	Position	Elevation
10:03 p.m.	288°	19°
10:04	271	31
10:05	227	42
10:06:05	182	31
10:06:20	176	28
Vanishes into Earth's shadow		

ISS, 7 June 2019

Time	Position	Elevation
21:12 p.m.	313°	22°
21:13	314	43
21:14	66	87
21:15	131	41
21:16	132	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.

Note that on May 21, Tiangong 2 and the International Space Station will reach their peak elevations simultaneously and almost in the same direction. Tiangong 2 will be much higher in the sky. Almost overhead, in fact. Thus, to see Tiangong at 9:07 p.m. on May 21, measure a little under three fist-widths west of north, then eight fist-widths above the horizon. (Alternatively, you could measure one fist-width north-west of vertical.) The ISS will be four-and-a-half fist-widths below it and a little west.

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>

Upcoming events: Not much of note. On May 29, cosmonauts Kononenko and Ovchinin will spacewalk, and that will be covered by NASA TV, but the exact time was unavailable at this writing.

Calendar of Events

May 10: 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.

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

May 18 – 26: 50th anniversary of *Apollo 10*, the second manned mission to orbit the Moon, and the first to test the Lunar Module in Moon orbit. Astronauts were Tom Stafford, John Young and Eugene Cernan.

June 7: Peak of the Arietid meteor shower.

June 9: Jupiter is at opposition.

June 12: Orion Ascent Abort-2 Test.

June 18: Mars is 0.3 degrees below Mercury.

June 22: Third launch of Falcon Heavy, this on the Space Test Program Flight 2 for the Air Force. This will carry 25 small satellites and a 5000 kg ballast mast which presumably will not be a Tesla Roadster.

June 23: Mercury is at greatest eastern elongation, 25 degrees from the Sun (hence is visible after sunset.)

July: Maiden flight for India's SSLV (Small Satellite Launch Vehicle.)

Mid-July: SpaceX unmanned launch to the ISS.

July [tentative]: Schedule date crewed test flight of SpaceX's Dragon 2 capsule, to the ISS. If this happens, it will be the first manned orbital launch by the US in eight years. However, after the loss of the Demo-1 Dragon Capsule on April 20, this flight will likely be delayed until next year.

July 2: Total eclipse of the Sun visible from South Pacific including Pitcairn Island, Chile and Argentina.

July 8: Saturn is at opposition.

July 9: launch of *Chandrayaan-2*, which includes a lunar orbiter, lander and rover. Postponed from April. See also September 6.

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

July 20: Launch of the Expedition 59 crew from Baikonur. This is the last scheduled Soyuz with a seat contracted by NASA.

July 24: Soyuz MS-13 launches to the ISS. This is the last Soyuz seat contracted by NASA.

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

August 12: Peak of the Perseid meteor shower.

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

August 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: 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.

September 9: Neptune is at opposition.

October 2: First operational mission of Dragon 2 to the ISS.

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.)

November: 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.

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

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

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

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.

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>.

Sometime in 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>.

February 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.)

April 2020: Second Starliner crewed mission to the ISS.

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 (KPLLO) 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: [Moved yet again]: 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.

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
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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.

Do you want to be on the Political Action Network?

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