

OKLAHOMA SPACE ALLIANCE

OUTREACH – November 2018

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet
2:00 p.m. on November 10, 2018
at Earl's Rib Palace,
920 SW 25th St, Moore, OK.
Directions are inside.



Figure 1: InSight Spacecraft Lands on Mars (NASA)

OKLAHOMA SPACE ALLIANCE OUTREACH November 2018

November Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on November 10, 2018 at Earl's Rib Palace, 920 SW 25th St, Moore, OK. This is between the I-35 West Frontage Road and Telegraph Road. Telephone number is 793-7427.

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, December 8 at the Koszorus'.

Saturday November 10, 2018

Program

Place: Earl's Rib Palace

Moore Oklahoma

2:00-5:00 PM

- 1) Introductions and review of Space events this past month
 - a. What's Happening in Space, News, Pictures, and Videos approximately one hour.
 - b. Short presentation of the National Space Society's Space Settlement Roadmap General Milestones 4-6
- 2) Break
- 3) Oklahoma Space Alliance Chapter Business Discussion
 - a. Review OSA treasurer's report
 - b. Summary of October meeting minutes
 - c. Space Roundup 2018 has been postponed until Spring 2019. Plans to carpool will be made closer to that date.
 - d. Nomination of Officers for 2019
 - e. Christmas Party
 - f. Review of OSIDA meeting
 - g. Other issues

Video: TBD given at the International Space Development Conference last May, in Los Angeles, CA. 45 minutes.
- 4) Chat

Christmas Party

The Oklahoma Space Alliance will have its annual Christmas Party on Saturday, December 8 at Tom and Heidi Koszoru's house in Norman. Prospective members are also welcome. The house is at 514 Fenwick Court in Norman. Prospective members are also welcome.

This will be the meeting at which we elect officers. You can vote at the meeting if you wish; or mail in or e-mail your ballot to sydh@ou.edu. Official start time is 5:00 p.m. This is a potluck except for main course.

To get the meeting either: (1) Take the Robinson Street west exit off I-35. Proceed west to 36th Street where you will turn left and go south until you turn left on Rambling Oaks (about half a mile north of Main Street). Fenwick Court is the third street on the left. Tom's house is the last on the left side, or (2) Take the Main Street west exit off I-35, proceed west past the Sooner Fashion Mall, and turn right at 36th Street, and go north until you turn right on Rambling Oaks (about half a mile north of Main Street). Fenwick Court is the third street on the left. The Koszoru house is the last on the left side.

Minutes of October Meeting

National Space Society's Oklahoma Space Alliance chapter held its regular monthly meeting on October 12, 2018 at Earl's Rib Palace in Moore, Oklahoma. In attendance were OSA President Dave Sheely, Mike Hopkins, Claire and Clifford McMurray, Tim Scott, Bryan Swift, Steve and Karen Swift, and Syd Henderson. Dave Sheely presided over the meeting.

Most of the "What's Happening in Space" segment was in last month's *Update*, (online at <http://osa.nss.org/Update1810.pdf>) so I'll just cover the highlights.

Lockheed-Martin has revealed plans to build a reusable Moon lander. We watched a video on the subject.

We watched a video on the Parker Space Probe. Although the PSP didn't have the fastest launch velocity, it will achieve by far the highest velocity attained by any space probe.

We watched a video on robots probing under the Ross Ice Shelf in Antarctica, a possible prelude to robotic missions under the ice of moons like Titan and Europa.

We watched an interview with Neil DeGrasse Tyson about the proposed Space Force.

We watched a video of "Vulcan" orbiting 40 Eridani. Vulcan orbits just inside the habitable zone.

We watched several episodes of "This Week at NASA," including photos of Hurricane Florence, an Orion Test Capsule landing, and the launch of ADEPT to test the heat shield. We saw the first light of TESS (the Transiting Exoplanet Survey Satellite), and a NASA anime site to show off spinoffs.

October 1 was the 60th anniversary of the creation of NASA.

We watched the return of astronauts from the ISS, a launch by SpaceX from Vandenberg (SpaceX's first from there), the Falcon 8 launching and landing after delivering Telstar 18 to orbit. Finally, we watched the last launch of a Delta II, on September 15. [Delta II's flew 155 times from February 1989 through October 2018, with only two failures, both in the mid-1990s.]

We have \$911.21 in the checking account and \$267 in cash for a total of \$1178.21.

We watched a video on the Space Launch System.

The Europa Probe would use an Earth gravitational assist to get to Jupiter in 4.5 years. A direct launch would take 2.8 years and could be launched by the SLS.

--Minutes by OSA Secretary Syd Henderson

Space News

Two of NASA's most successful missions ended within two days last week, and it looks more and more like a third one is also at an end.

Mars Rover *Opportunity* ceased communications on June 10 and went into hibernation (we assume) on June 12, near the beginning of a planetwide dust storm that lasted until early October. It was hoped that when the dust started to die down in September, that *Opportunity* would power up enough to resume communications, but that has not happened. There is still a chance that winds over the next couple of months will clear the solar panels, but for now the mission appears to be over after fourteen and a half years

On October 30, the *Kepler* Space Telescope's mission ended when it finally ran out of fuel nine years and five months after launch. Actually, Kepler had two missions: from May 2009 through May 2013, Kepler viewed a rather small area at the intersection of Cygnus, Lyra and Draco and found more than 3000 potential planets, though the number of those that have been confirmed is much less. (Stars in this direction are about the same distance as the Sun from the Galactic Center.)

The second Mission, called Kepler 2, lasted from the spring of 2014 through the end of the mission. In this part of the mission, Kepler observed sections of the sky in the plane of the ecliptic, which enabled it to compensate for the loss of two of its four reaction wheels by tacking against sunlight. During its two missions, Kepler observed half a million stars and confirmed more than 2600 exoplanets. This is 68% of the exoplanets so far discovered.

Kepler is in a heliocentric orbit with a period of 372 days so is gradually moving away from the Earth. At the time of its retirement, it was 94 million miles away from the Earth. (This suggests to me that it's in the vicinity of the Earth-Sun L5 point, but I haven't been able to confirm that.)

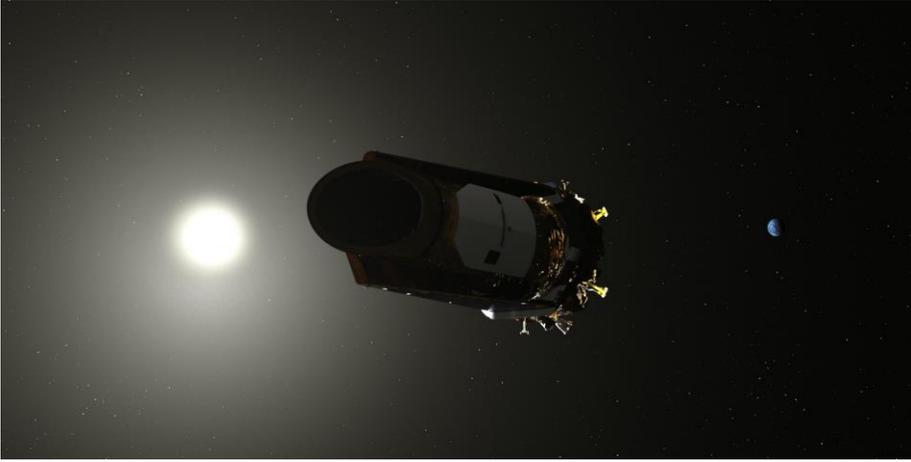


Figure 1 Kepler Space Telescope (NASA Artist)

On November 1, NASA announced that the asteroid probe *Dawn* had also run out of fuel. Dawn was launched on September 27, 2007, so its mission lasted eleven years and a month. For thirteen months from the summer of 2011 through the summer of 2012, it orbited 4 Vesta, the second largest asteroid in both mass and diameter, and, from Earth, the brightest. It then went on to Ceres, the largest asteroid, which it has orbited since March 6, 2015. Actually, Ceres is so large that it has been rounded by gravity, and is also considered a dwarf planet. Ceres has an icy shell 60 miles thick but appears like a generic cratered body. Vesta is somewhat more exciting because it appears to be the sole surviving protoplanet in the asteroid belt. (It's not a dwarf planet because it hasn't been made round by gravity.)

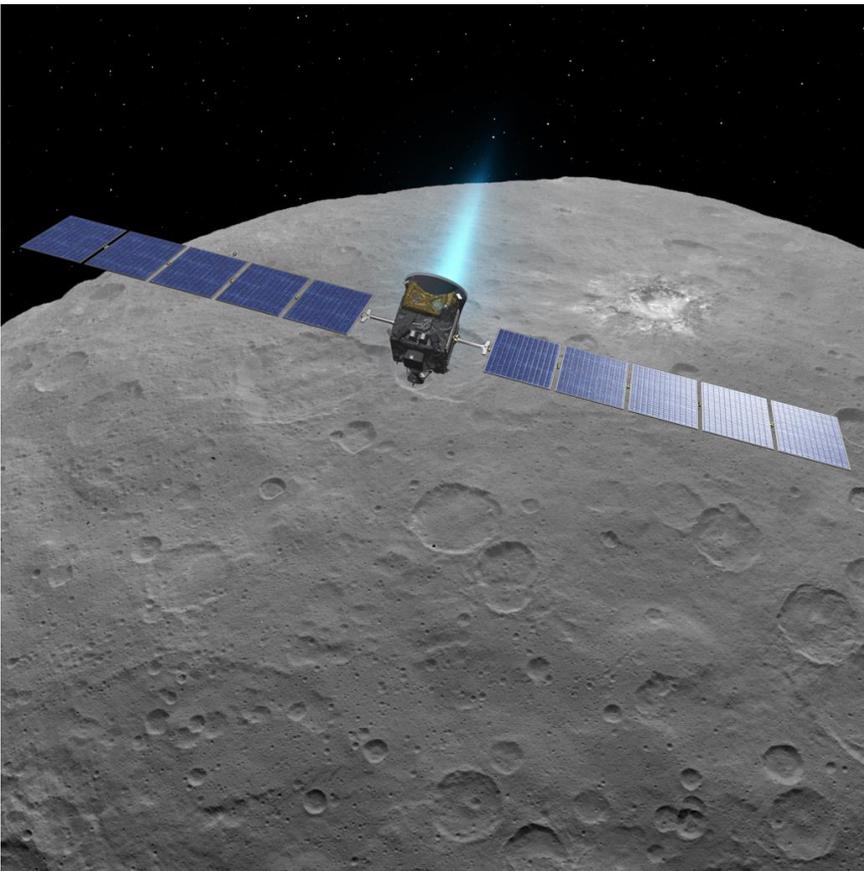


Figure 3 Dawn at Ceres (NASA Artist's Conception)

Even if *Opportunity*, hasn't survived, *Curiosity* (which is nuclear-powered) continues to rove, the *InSight* lander will arrive at Mars on November 26, *InSight* will land at the Elysium Planitia, one of the flattest places on Mars, the better to study seismic waves and analyze the interior of Mars. Also, on November 26, the Cubesats MarCO A and B will fly by Mars. (Also, the SpaceX capsule containing Elon Musk's Tesla Roadster has just gone outside the orbit of Mars, although it's not close to the planet.)

It looks like 2020 will be a busier year for Mars, with the arrival of the Mars 2020 rover launched by NASA, the *ExoMars* rover by ESA, a rover, lander and orbiter and by China, and the *Hope* Mars probe by the United Arab Emirates,

Kepler's mission is already being followed up by *TESS* (the Transiting Exoplanet Survey Satellite), which will be joined by the ESA's *CHEOPS* exoplanet hunter early next year. Eventually the James Webb Space Telescope will also be checking up on the candidate exoplanets *Kepler*, *TESS* and *CHEOPS*.

The *Parker Solar Probe* is starting to set some records. On October 29, it became the space probe to get closest to the Sun, passing *Helios 2*'s 1976 closest approach of 26.55 miles. Later that day, it reached a velocity of 154,000 mph with regards to the Sun, making it the fastest spacecraft by that measure (also beating our *Helios 2*). It still hadn't broken the speed record with respect to Earth, but since that record, held by the *Juno* Jupiter probe, is 165,000 mph, the *Parker Solar Probe* will break that too on this run. At its closest approach to the Sun, the *Parker Solar Probe* will be travelling more than 420,000 mph. Its orbital period at time will be 88 days, exactly the same as Mercury's, but the orbit will be much more elliptical.

Speaking of Mercury, the ESA's *BepiColombo* was launched on October 20 and will arrive in orbit around Mercury in December 2025 after one flyby of Earth, two by Venus and six by Mercury. Fittingly, it gets its name from Giuseppe "Bepi" Colombo, who in 1974 used a gravitational assist by Venus to help send *Messenger 10* to Mercury. This was the first time a spacecraft used a gravitational assist from another planet (although at least one had used the Moon). The technique would become much more famous in a few years when *Voyager 1* and *Voyager 2* used it to visit the outer planets.

Sky Viewing

The **Geminids** are one of the prominent meteor showers and are expected to produce about 120 meteors per hour at their peak around 6:30 a.m. on December 14. A fair number of meteors will appear on the evenings of December 13 and 14, but the best time to look is the morning of December 14. There is a crescent Moon in the evening. Finding the radiant is easy: Gemini is north of Orion and forms a bright, long triangle pointing south. The two bright stars at the top of Gemini are Castor and Pollux. Pollux is the brighter of the two, but the radiant is nearer Castor. The radiant is at the meridian around 2:00 a.m. You don't have to look at the radiant to watch the shower; it just gives you an idea of where they'll appear to move away from.

The Geminids are unusual because they are not debris from a comet, but from an asteroid, the sungrazer 3200 Phaethon, which sheds rocky material as it approaches to within 14 million miles of the Sun.

Also during the two-month period between issues of *Outreach*, we have the Leonid meteor shower which will peak on November 17. Although the Leonids have been prominent in the past, this year they are expected to peak at 10-15 per hour, and, worse, the gibbous Moon will wash many of them out.

The Leonids originate from Comet Tempel-Tuttle, which has a period of thirty-three years and emits a lot of debris when it approaches the Sun, producing what are called meteor storms (more than a thousand meteors per hour), which happen, naturally, in a thirty-three years cycle, sometimes for several years in a row. The last of these meteor storms were in 1999, 2001 and 2002 and the next will be around 2034, and we are almost exactly halfway between the peaks.

The only other meteor shower in the northern sky during November and December are the minor Ursids, which peak on December 22. The radiant for these is near Kochab, the second brightest star in Ursa Minor, but there will only be about ten meteors per hour and the peak coincides with the Full Moon.

Mercury was at greatest eastern elongation on November 6, but the Ecliptic is at such a shallow angle at sunset this month that it is still low in the sky at twilight. **Jupiter** is about eight degrees to the right of **Mercury** and should be easier

to see, but it is low in the sky. The two planets are both heading for conjunction with the Sun. Jupiter in in conjunction on November 26, and Mercury follows the next day.

Both planets will reappear in December. In fact, Mercury will be visible in the morning starting around December 6, and by December 15 will be rising 100 minutes before the Sun. It will then be magnitude -0.5.

At the same time, Jupiter will be rising about an hour before the Sun and will be magnitude -1.7.

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

Given their proximity in the sky, it's not surprising that we have a conjunction of Jupiter and Mercury in December, and it happens on December 21, when Jupiter passes less than a degree from Mercury. However, they'll be low in the sky at that time.

Venus was at inferior conjunction with the Sun on October 26. However, the ecliptic is nearly perpendicular to the horizon at sunrise in November (in contrast to the situation at sunset), and Venus is already rising about an hour before sunrise on November 10, and three-and-a-half hours before Sunrise at the end of November, when it will shine at magnitude -4.9, as bright as Venus gets. Venus stays about that bright through December, not reaching greatest elongation until January 6, 2019.

Mars is still prominent in the evening sky, shining at magnitude -.5 due south at sunset and not setting until midnight. Mars will actually be setting around 11:30 p.m. throughout December though it will be getting dimmer, fading to magnitude -0.1 at the beginning of December and magnitude 0.5 at the end. It will be in Pisces and Aquarius, neither of which have first magnitude stars, so it will still be the brightest object in the vicinity.

Saturn is also fading, down to magnitude 0.5, and is setting about three hours after the Sun. By the end of November, that will be down to two hours, and Saturn will disappear in the twilight by mid-December. Saturn will be in conjunction with the Sun on January 2, 2019.

Uranus and **Neptune** are both in the evening sky but are both hard to find since there are few bright stars to act as signposts, except on December 7, when Neptune gets only two seconds of arc away from Mars. The closest approach is unfortunately after sunrise, but they will be close on the nights of December 6 and 7. [Finder charts for Uranus and Neptune are online at wwwcdn.skyandtelescope.com/wp-content/uploads/WEB_UrNep18.pdf.]

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

Viewing Opportunities for Satellites (November 9 – December 14)

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. I'm including data for Tiangong 2, which can get up to magnitude 1.0 at least.

Missions to and from the International Space Station or Tiangong-2 may change its orbit. Northrup Grumman will be launching a resupply mission to the ISS on November 15, and a Progress cargo craft on November 16 (though I doubt these will change the ISS's orbit). The next manned launch to the ISS is on the morning of December 3.

HST, 9 November 2018

Time	Position	Elevation
6:10 p.m.	223°	20°
6:11	204	27
6:12	177	31
6:13	149	27
6:14	130	20

Tiangong -2, 9 November 2018

Time	Position	Elevation
6:34 p.m.	299°	10°
6:37	26	77
6:38:24	108	29
Vanishes into Earth's shadow		

HST, 10 November 2018

Time	Position	Elevation
6:00 p.m.	226°	21°
6:01	207	28
6:02	179	32
6:03	151	28
6:04	132	21

Tiangong -2, 11 November 2018

Time	Position	Elevation
6:14 p.m.	289°	10°
6:17	211	52
6:20	134	10

Tiangong -2, 23 November 2018

Time	Position	Elevation
6:30 a.m.	219°	10°
6:33	147	41
6:36	75	10

ISS, 23 November 2018

Time	Position	Elevation
6:31 p.m.	271°	21°
6:32	208	40
6:33	138	71
6:34:20	64	40
6:35:36	60	33

Vanishes into Earth's shadow

Tiangong -2, 25 November 2018

Time	Position	Elevation
Appears from Earth's Shadow		
6:10 a.m.	240°	16°
6:12	154	85
6:16	64	10

ISS, 25 November 2018

Time	Position	Elevation
6:23 p.m.	259°	18°
6:24	279	30
6:25	322	40
6:26	6	30
6:27	25	18

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 see the International Space Station at 5:57 p.m. on December 14, measure three-and-a-half fist-widths north from due west then just over 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>

Live highlights (all times are Central Daylight Time):

Tiangong -2, 6 December 2018

Time	Position	Elevation
6:43 a.m.	291°	12°
6:46	210	65
6:49	127	10*

*Passes just above Spica and a couple of degrees below Venus
ISS, 11 December 2018

Time	Position	Elevation
6:58 p.m.	313°	21°
6:59	314	41
7:00:19	316	81

Vanishes into Earth's Shadow somewhere between 62 and 81 degrees above horizon.

ISS, 12 December 2018

Time	Position	Elevation
6:06 p.m.	335°	19°
6:07	354	31
6:08	38	40
6:09	82	30
6:10	101	18

ISS, 13 December 2018

Time	Position	Elevation
6:50 p.m.	282°	16°
6:51	263	25
6:52	228	31
6:53	217	25
6:54	174	16

ISS, 14 December 2018

Time	Position	Elevation
5:57 p.m.	305°	21°
5:58	296	40
5:59	225	71
6:00	152	40
6:01	143	21

November 15, 3:15 a.m. Coverage of the launch of the Cygnus CRS-10 craft to the ISS (actual launch is 3:49 a.m.)

November 16, noon: Coverage of launch of Progress 71 cargo craft to the ISS. (Actual launch is 12:14 p.m. at Baikonur Cosmodrome, Kazakhstan.)

November 18, 2:00 a.m.: Coverage of capture of Cygnus CRS-10. (Actual capture is 3:35 a.m.) 12:45 p.m.: Coverage of capture of Progress 71. (Actual capture is at 1:29 p.m.)

December 3, 4:30 a.m.: Coverage of launch of Expedition 58 to the ISS (Launch is 5:31 a.m.) 10:45 am: Coverage of docking with the ISS (docking is at 11:30a.m. 1:00 p.m.: Hatch opening and welcoming ceremony for Expedition 58. (Hatch opening is around 1:30 p.m.)

Calendar of Events

November 9: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a Star Party at Tenkiller State Park at 8:00 p.m.. (There's a second night of star partying on November 10.) See <http://www.okcastroclub.com/> for details.

November 10: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

November 26: *InSight* Lander lands on Mars. For more information, visit mars.nasa.gov/insight/mission/time-line/landing/entry-descent-landing/

November 26: Jupiter in conjunction with the Sun.

November 27: Mercury is in inferior conjunction with the Sun.

December 3, 5:31 a.m.: Expedition 58 launches for the ISS, carrying NASA astronaut, Anne McClain, Canadian astronaut David-Saint-James, and Russian cosmonaut Oleg Kononenko.

December 4, 12:38 pm.: SpaceX Cargo mission to the ISS.

December 7. Mars is only two seconds of arc south of Neptune at 8:55 p.m. CST. In other words, this is the best possible time to find Neptune.

December 8: China launches the *Chang'e 4* lunar lander and rover, which will be the first to land on the far side of the Moon. The Queqiao relay satellite was launched on May 20. Landing site is the Von Karman crater, which is thought to be the oldest impact crater on the Moon. For more information, see https://en.wikipedia.org/wiki/Chang%27e_4.

December 8: [Tentative] Oklahoma Space Alliance Christmas Party, 5:00 p.m., Koszoru house, 514 Fenwick Court in Norman.

December 13: Expedition 57 returns for the ISS.

December 14: Peak of Geminid meteor shower.

December 14: 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 15: Mercury is at greatest western elongation, 21 degrees west of the Sun (hence is visible before sunrise), in the constellation Libra.

December 20: Return of Expedition 57 from the ISS.

Early 2019: Launch of the European Space Agency's CHEOPS space telescope, which will study exoplanets which transit their star's disc. Project website is <http://sci.esa.int/cheops>.

Early 2019: [Moved from December 2018] Boeing's CST-Starliner makes its first crewed flight. This will be the first American spacecraft to carry astronauts to orbit since 2011. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

Early 2019: SpaceX launches SpaceIL's *Sparrow* Moon lander, which was one of the Google Lunar X-Prize contestants. For information, see https://en.wikipedia.org/wiki/SpaceIL#Sparrow_lander or www.spaceil.com.

Sometime in 2019: China launches the *Chang'e 5* lunar sample return mission. This will be the first spacecraft to return material from the Moon since 1976 (the Soviet Union's *Luna 24*.)

January 2019: Second launch of Falcon Heavy, carrying Arabsat 6A.

January 2019: SpaceX will launch an unmanned Dragon-2 capsule to the International Space Station.

January 1, 2019: *New Horizons* flies by Kuiper Belt object 2014 MU₆₉.

January 2, 2019: Saturn is in conjunction with the Sun.

January 6, 2019: Venus is in greatest western elongation, 46 degrees from the Sun (hence is visible before sunrise.)

January 11, 2019: 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.

January 12, 2019: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

January 29, 2019: Mercury is in superior conjunction with the Sun.

January 30, 2019: Projected date that India's *Chandrayaan-2* may be launched to the Moon. The mission includes a lander, rover and orbiter, the first two landing near the south pole of the Moon. For more information, see <https://en.wikipedia.org/wiki/Chandrayaan-2>.

February 8, 2019: 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.

February 9, 2019: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

February 26, 2019: Mercury is at greatest eastern elongation, 18 degrees from the Sun (hence is visible after sunset.)

March 2019: [Moved from November 30] 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.

March 2019: Boeing's CST-Starliner makes an automated uncrewed flight to the ISS.

March 14, 2019: Mercury is at inferior solar conjunction.

April 11, 2019: Mercury is at greatest western elongation, 27 degrees west of the Sun (hence is visible before sunrise). This is a poor elongation due to the shallow angle of the ecliptic with respect to the horizon.

April 12, 2019: Yuri's Night: 58th anniversary of orbital manned space flight.

June 2019: SpaceX will carry a crew of NASA astronauts to the ISS. If this happens as scheduled, this will be the first American spacecraft to carry astronauts to orbit since 2011, but note that this has been postponed several times.

July 20, 2019: 50th Anniversary of *Apollo 11* landing on the Moon.

July 24, 2019: Soyuz MS-13 launches to the ISS. This is the last Soyuz seat contracted by NASA.

August 2019: [Moved from December 2018] Boeing's CST-Starliner makes its first crewed flight. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

Fall of 2019: 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>.

September 2019: 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/>.

November 11, 2019: Mercury transits the Sun.

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>.

Sometime in 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

Sometime in 2020: Launch of the Korea Pathfinder Lunar Orbiter by SpaceX. This will be South Korea's first lunar mission, and will also include an impactor.

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

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

July 2020: United Arab Emirates launch the Mars probe *Hope*, aka as *Al-Amal* or the *Emirates Mars Mission*. 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.

July or August 2020: Launch of the Mars Global Remote Sensing Orbiter, Lander and Small Rover by China.

July 25, 2020: ESA launches the *ExoMars Mars Rover* 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.

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

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

March 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 Bennu.

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, 2018 (Area Code 405)

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E-mail for OSA should be sent to sydh@ou.edu. Members who wish their e-mail addresses printed in *Outreach*, and people wishing space-related materials e-mailed to them should contact Syd. Oklahoma Space Alliance website is osa.nss.org. Webmaster is Syd Henderson.

Other Information

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

Science Museum Oklahoma (former Omniplex) website is www.sciencemuseumok.org. Main number is 602-6664.

Tulsa Air and Space Museum, 7130 E. Apache, Tulsa, OK 74115.

Web Site is www.tulsaairandspacemuseum.com. Phone (918) 834-9900.

The Mars Society address is Mars Society, Box 273, Indian Hills CO 80454. Their web address is www.marsociety.org.

The National Space Society's Headquarters phone is 202-429-1600. 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 www.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.

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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.**