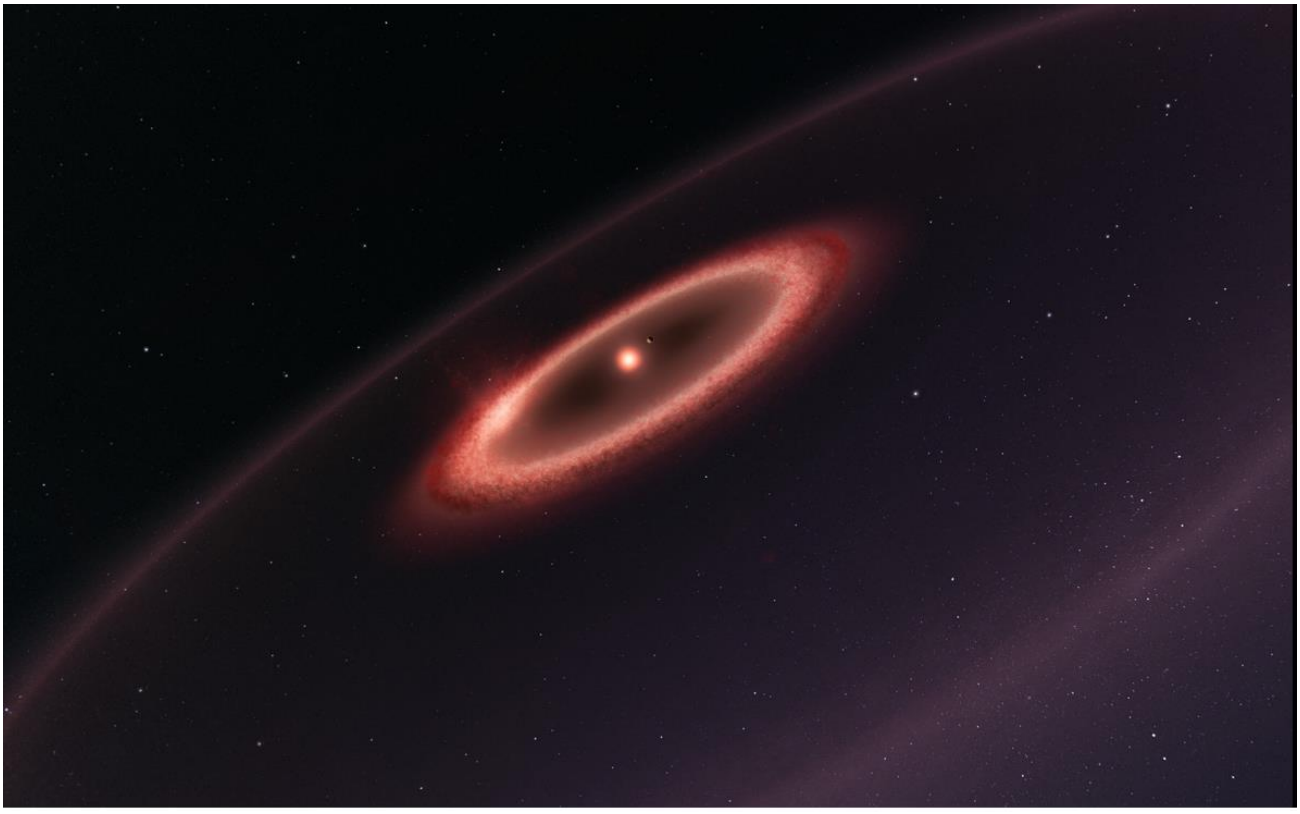
OKLAHOMA SPACE ALLIANCE

OUTREACH – November 2017

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet
2:00 p.m. on November 11, 2017
at Earl's Rib Palace,
920 SW 25th St, Moore, OK.
Directions are inside.



Artist's Conception of Rings around Proxima Centauri (See "Space News, p. 3s") Source: Wikipedia,

Oklahoma Space Alliance OUTREACH
November 2017

November Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, November 11, 2017 at Earl's Rib Palace, 920 SW 25th St, Moore, OK. This is between the 1-35 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. Elections will be held at the Christmas Party.

Saturday November 11, 2017
Program

Place: Earl's Rib Palace
Moore Oklahoma
2:00-5:00 PM

1) Introductions
2) What's Happening (Steve Swift)
   (Pictures, Videos & Links)
3) Discuss Business
   a. Review OSA Accounts
   b. Summary of October Meeting
   c. Nomination of Officers
   d. Discussion / Action on Bylaws
   e. Heinlein Award voting
   f. New Business
4) Feature Topic – OSA Last 7 Years Highlights
   (Steve Swift), (Pictures, Videos & Links),
   Accomplishments, Quotes, Movers and Shakers, Major Events, Significant Trends
5) OSA Member Presentations/Discussions
6) Chat

We will be continuing our votes on the Heinlein Award at this meeting. Our chapter gets a vote, and each paid member of Oklahoma Space Alliance gets to vote on the chapter's choice. Syd will tabulate the votes and mail them in. If you can't make the meeting, e-mail your vote to sydh@ou.edu before noon on the November 11.

If you are a member of the National Space Society, you also get an individual vote, which you can cast at http://www.nss.org/heinlein-ballot.php (which also gives you a list of previous nominees). Deadline for voting is November 30.

Previous award winners are not eligible. Previous award winners are**:** Dr. Gerard K. O'Neill, Sir Arthur C. Clarke, Dr. Wernher von Braun, Gene Roddenberry, Dr. Robert H. Goddard, Dr. Buzz Aldrin, Dr. Carl Sagan, Neil Armstrong, Robert Zubrin, Capt. James Lovell, Gen. Chuck Yeager, Burt Rutan, Dr. Peter Diamandis, Dr. Stephen Hawking, Elon Musk, Dr. Jerry Pournelle. Write-ins are encouraged, and can appear on next year's ballot.

Minutes of October Meeting

Oklahoma Space Alliance held its regular monthly Meeting on October 14 at Earl's Rib Palace in Moore, Oklahoma. In attendance were Mike Hopkins, Tom Koszoru, Claire and Kip McMurray, John Northcutt, Dave Sheely, Tim Scott, Christopher Taylor and Syd Henderson. OSA President Steve Swift was unable to attend, so in his absence, OSA Vice President Dave Sheely presided.

Dave did an *Update* that contained links to much that was discussed, so I'll confine myself to highlights. Dave's *Update* is online at http://chapters.nss.org/ok/Update1710.pdf.

We watched a Space X video promoting space exploration, and a video promoting their BFR earth to earth.

We watched a video on Blue Origin, which has been selected as a launch provider for the Thai satellite company mu Space. This company is in the business of producing communications satellites for Thailand. Mu Space is the second customer for the New Glenn launcher.

We also watched a video on the New Glenn launcher.

We watched a brief video on the first meeting of the National Space Council.

We watched a promotional video on Bigelow's expandable space modules.

We took a preliminary poll on the Heinlein award and are waiting on more votes.

We looked at a list of proposed bylaws.

We watched a video of Elon Musk, "Becoming a Multi-Planet Species."

Treasury: We have $1041.70 in checking account and $267 in cash.

The November meeting is when we nominate officers. Steve Swift is retiring as President and Dave Sheely will run for the office.

Space News

Apparently, China is not going to launch a *Tiangong-3* space station after all, merging its mission with that of *Tiangong 2*.

This comes just after an announcement that problems with the Long March 5 launcher have caused the *Chang'e 5* lunar sample mission to be delayed until the end of 2018 or, more probably, early 2019. The Long March 5 is the most powerful of China's current launchers, and is the only one capable of launching *Chang'e 5* and the pieces of *Tiangong-2*.

The failure of the second flight of the Long March 5 launcher has been traced to a manufacturing defect in its YF-77 engine and is said to be easily fixed. China's other new rockets, Long March 6 and 7, use the YF-100 engine and are not affected, and not as powerful.

Last year, astronomers announced the detection of a planet in the habitable zone around Proxima Centauri, the nearest star to the Sun. It now appears that Proxima b may not be alone. Proxima Centauri has at least one ring of dust four between one and four astronomical units from Proxima, and probably has

several, and quite possibly another planet. Proxima b, which is 0.05 astronomical units from Proxima, is well inside any possible ring, (An astronomical unit is the average distance of the Earth from the Sun, about 93 million miles.) Although this distance suggests an asteroid belt, the dimness of Proxima makes it more likely to be a Kuiper-type belt of icy bodies. Since our Kuiper belt contains sizeable dwarf planets such as Pluto and Eris, Proxima's may well have the same. There are also hints of rings at 0.5 and 30 a.u.. By comparison, Neptune is about 30 a.u. from the Sun. If all these dusty rings exist, it suggests Proxima has enough matter orbiting it to form several planets.

In other news about Proxima, simulations of Proxima's orbit around Alpha Centauri A and B by Fabo Feng and Hugh Jones of the University of Hertfordshire in the UK reveal during a ten-billion-year time frame, Proxima Centauri leaves the Alpha Centauri system 26 percent of the time. This indicates that Proxima was probably captured by the other stars rather than formed together with them. There was already speculation that this must be true since Proxima contains much less metal than the other members of the trio. ("Metal" here in the astronomical sense meaning elements other than hydrogen and helium.) [*New Scientist*, 23 September, page 11.

Stratolaunch Systems is about to begin flight testing of the world's largest aircraft, a 385-foot wide monster with two fuselages, a takeoff capacity of 650 tons, and a load capacity of 273 tons. The Stratolaunch aircraft is nicknamed "Roc" because of course it is. Expect flight testing early next year, with operations beginning in 2019.

A new paper published online at *Nature Astronomy* (part of the nature.com website) postulates that if the core of Enceladus is made of porous rock, tidal heating resulting from Enceladus's elliptical orbit around Saturn might be sufficient to heat up water which eventually erupts in geysers. It's been a mystery why Enceladus has an internal source of heat since it's too small and light to have a lot of radioactive elements, if the heating were caused by tidal forces in the ice shell, Enceladus would have frozen solid in thirty million years.

On October 3, Rainer Weiss, Barry Barish and Kip Thorne got a quick Nobel Prize for LIGOs direct detection of gravitational waves, just a year after the detection was made. Interesting, just a few days later, another announcement was made by LIGO and other teams that was just as important as the first, if not more so. We'll have to how quickly this gets a Nobel Prize.

Last August 17, LIGO detectors in Washington State and Louisiana, and the Virgo detector in Italy detected the collision of two neutron stars. A few seconds later gamma rays were detected from the same location. This indicated right away that gravitational waves move at the speed of light in a vacuum. Since they had three detections of gravitational waves, they could narrow the location of the event to the southern part of the constellation Virgo and the eastern part of Hydra. The Henrietta Swope telescope team used the data got a decent estimate of the distance to the source, searched galaxies at the right distance in that part of the sky, and discovered a "star" in the galaxy NGC 4993 in Hydra. The "star" is 130 million away and has an apparent magnitude of 17, which at that distance indicates a kilonova type explosion, which simply means it was a thousand times as bright as a nova (but less bright than a supernova). This was the first observation of the same object using gravitational waves and electromagnetic radiation.

Since the merger of the stars produced a gamma-ray burst, we now know where some, and probably most of those bursts come from.

Furthermore, the collision of the neutron stars resulted in a lot of ejected, neutron-rich matter which decayed quickly into heavy elements such as thorium, uranium, bismuth, iridium, platinum and gold. Indeed, for many of these, neutron star collisions may be the major source, although for more middle-weight elements, other mechanisms involving low-mass stars apparently work somehow. Supernova explosions seem to only account for elements up to rubidium (and some strontium, yttrium and zirconium).

One thing that occurred to me is that colliding neutron stars can bypass the fermium barrier that prevents us from creating higher elements through bombarding nuclei with neutrons. The isotope Fm-258 has a lifetime of 370 microseconds, and Fm-259 and Fm-260 have lifetimes of 1.5 seconds and 4 milliseconds, all decaying by spontaneous fission, so elements cannot be formed from those isotopes, and no lighter isotopes of Fermium decay by Mendelevium. However, if neutron star collisions release isotopes with enormous numbers of neutrons, they may actually decay into isotopes in the so-called island of stability believed to lie beyond element 114. Since spectrographic analysis of the ejected material from the neutron stars revealed rare earths, gold, platinum and lead, perhaps we should look for more exotic nuclei.

Apparently, there wasn't an X-ray burst, which is a puzzle, and leads to speculation that the final product of the collision was a black hole. Although some scientists are hedging their bets because the ejected material may be blocking the X-rays.

Meanwhile, in mid-October, astronomers detected an 20th magnitude object that came within 23.4 million miles of the Sun. What made this remarkable is that the object was going so fast that it had a hyperbolic orbit, which means it's travelling faster than escape velocity for the Solar System, and presumably was the first known interstellar object to visit the Solar System. At first, astronomers though it was a comet, but some now think it's a flyby asteroid.

Last January 17, the dwarf planet Haumea occulted an 18th magnitude start and astronomers (with really large telescopes) all over the world took the rare chance to learn more about the unusual dwarf planet. Haumea was already known to be strange, with its diameter from pole to pole only half of its equatorial diameter and a rotational period of only four hours. Nevertheless, it qualifies as a dwarf planet because it's rounded by gravity despite being shaped like a giant M &M.

Haumea also has two small moons, but was unexpected was that Haumea has a ring. It has a radius of 1400 miles (compared to a 700-mile equatorial radius for Haumea itself) and is 50 miles wide. It's located so that particles in the ring make three orbits per rotation of Haumea, so there's a resonance factor involved.

The occultation also gives us much better information on Haumea's size. Its longest diameter is 1400 miles and its shortest is about 600 miles. This means it's the third-largest dwarf planet that has been discovered in the Kuiper belt, trailing Pluto and Eris. It also has a density 1.9 times that of water, which means it's about as dense as Pluto and probably has a similar composition.

Although Haumea is the first trans-Neptunian object in the Solar System known to have rings, the Centaur asteroids Chiron and Chariklo, which orbit between Saturn and Uranus, also have rings, and it's likely many other Kuiper Belt Objects do.

Sky Viewing

We have three meteor showers of note between this and the next issue of *Outreach*, all of which have Moonless skies to shoot through.

The first are the **Leonids**, which peak on the night of November 17-18, which just happens to be the date of the new Moon, so the sky will be nice and dark. Unfortunately, the Leonids, which were very good a decade or so ago, are now in a sparser part of their orbit and will peak at around fifteen meteors per hour.

Much more promising are the **Geminids**, which peak on the night of December 13-14. The Moon won't be rising until late morning and will be a crescent, so won't be much of a factor. The radiant is in the bright constellation Gemini, which will be high in the sky. Furthermore, the Geminids offer up to 120 meteors per hour and a fair number of these are before midnight, and some show up a few days before and after the peak. This is not only the best meteor shower of the fall, but of all 2017.

Finally, there are the **Ursids**, which peak on the morning of December 22. By this time the Moon has passed the New Moon stage and is a crescent in the other direction, making a graceful exit soon after sunset. Surprisingly, the radiant is not Ursa Major, but near Kochab, the fairly bright star at the opposite

end of the Little Dipper (Ursa Minor) from Polaris. This means the spot the meteors appear from is above the horizon all night, and meteors can appear any time, though the best time is just before morning twilight, Unfortunately, the Ursids are more like the Leonids this year than the Geminids, probably peaking at 10-15 meteors per hour, but some years considerably higher. Nobody really knows what to expect because meteor buffs tend to concentrate on the prominent Geminids.

Mercury is currently not visible after sunset, but that will change as it approaches greatest elongation on November 17, at which point it will be magnitude -0.4, but still very low over the horizon. Mercury falls into twilight toward the end of November as it approaches inferior conjunction in mid-December but will appear in the morning sky starting around December 23, and be relatively conspicuous by the end of the month.

Venus is still rising about 75 minutes before the Sun, and, although it is dim for Venus at magnitude -3.9, it's still the second brightest nighttime object by quite a margin. By the end of the month, Venus will be rising 45 minutes before the sun and quickly disappear from the night sky in mid- December as it approaches superior conjunction with the Sun on January 9. (On the bright side, this means Venus will be the Evening Star from February to the beginning of October 2018.)

Jupiter was in conjunction with the Sun on October 26, and is still lost in sunrise at the beginning of December. This means that it and Venus are going in opposite directions in the sky, and they will be only a third of a degree apart on the morning of November 13, although they'll be so low in the sky you'll need a clear skyline and probably binoculars. Jupiter is magnitude -1.7, which is considerably less bright than Venus, but brighter than any stars in the area. Jupiter will become more visible later in November, and by the end of the month will be rising two hours before the Sun, and four hours before the Sun at the end of December.

Mars is currently rising about three hours before the Sun, but is still far from us and magnitude 1.7. Mars moves more slowly across the star field that Jupiter, so that Jupiter will be playing catchup through December, finally catching up to Mars on January 5 when Mars will be only a fifth of a degree north of Jupiter. (By comparison, the full Moon is half a degree across.) Mars will still be only magnitude 1.5 at the end of December, but it's going from a very distant conjunction to its closest opposition in fifteen years, which will take place in late July, and will be brightening from now till then,

Saturn is magnitude 0.5 and is low in the southwest at sunset. By the end of November, it will be lost in sunset, reaching conjunction with the Sun on December 21.

Incidentally, this means that after the beginning of December, there will be no bright planets in the night sky at all until Mars rises around 3:00 a.m. The evening sky will be bare until Venus returns in late January. There will be a couple of faint planets, though. **Uranus** is well up in the southeast at sunset, in a faint part of the constellation Pisces, and **Neptune** is one constellation west in Aquarius. Both are above the horizon through the evening, and will be through the end of December. Unfortunately, Uranus is magnitude 5.7, which makes it difficult to see with the unaided eye even in a pitch-black sky, and Neptune requires strong binoculars at least. If you wish to look for them, *Sky & Telescope* has finder charts on page 50 of their October issue, and at http://wwwcdn.skyandtelescope.com/wp-content/uploads/WEB_Uranus_Neptune17.pdf.

Viewing Opportunities for Satellites (November 11 - December 14, 2017)

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 Microsoft Explorer to run it. 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 1 or Tiangong 2, so I'm using Heavens Above for those. The *Sky & Telescope* web

site carries International Space Station 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 -3.5, 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. China's Tiangong 1 space station can get up to magnitude -0.6, which is brighter than all the night stars except Sirius and Canopus. With this issue, I'm also including data for Tiangong 2, which can get up to magnitude 0.4 at least.

Missions to and from the International Space Station or Tiangong-2 may change its orbit. An Orbital ATK resupply mission is launching to the ISS on the morning of November 11. There's also a SpaceX resupply mission which may occur in December. The next manned launch to the ISS is currently scheduled for December 17. I know of no scheduled manned flights to Tiangong-2. Tiangong-1 has been abandoned and will reenter the Earth's atmosphere sometime in the next six months.

Tiangong 2 November 11, 2017

Time	Position	Elevation
6:12 p.m.	305°	10°
6:15	21	48
6:17	93	16

Vanishes into Earth's Shadow

Tiangong 2 November 12, 2017

Time	Position	Elevation
6:50 p.m.	287°	10°
6:53	212	47
6:55	151	31

Vanishes into Earth's Shadow

Tiangong 2 November 13, 2017

Time	Position	Elevation
5:52 p.m.	287°	10°
5:55	32	89
5:59	118	10

ISS November 16, 2017

Time	Position	Elevation
6:24 a.m.	313°	21°
6:25	315	41
6:26	29	87
6:27	130	42
6:28	131	22

HST November 18, 2017

Time	Position	Elevation
6:44 a.m.	222°	20°
6:45	204	27
6:46	177	30

Vanishes into Earth's Shadow

HST November 19, 2017

Time	Position	Elevation
6:33 a.m.	225°	20°
6:34	207	27
6:35	191	31

Vanishes into Earth's Shadow

HST November 20, 2017

Time	Position	Elevation
6:23 a.m.	228°	20°
6:24	209	27
6:25	182	30

Vanishes into Earth's Shadow

Tiangong 1 November 24, 2017

Time	Position	Elevation
6:14 p.m.	226°	10°
6:15	150	49
6:16	87	26

Vanishes into Earth's Shadow

Tiangong 1 November 25, 2017

Time	Position	Elevation
6:14 p.m.	226°	10°
6:15	335	66
6:16	47	34

Vanishes into Earth's Shadow

ISS November 27, 2017

Time	Position	Elevation
6:15 p.m.	218°	22°
6:16	209	41
6:17	133	72
6:18	62	40
6:19	55	21

ISS November 29, 2017

Time	Position	Elevation
6:06 p.m.	260°	19°
6:07	279	30
6:08	322	40
6:09	6	31
6:10	25	19

Tiangong 1 December 6, 2017

Time	Position	Elevation
5:59 p.m.	301°	10°
6:01	25	66
6:04	109	10

HST December 13, 2017

Time	Position	Elevation
Appears from Earth's shadow		
5:55:13 p.m.	177°	30°
5:56	156	27
5:57	132	20

HST December 14, 2017

Time	Position	Elevation
Appears from Earth's Shadow		
5:45 p.m.	180°	31°
5:46	153	27
5:47	134	20

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 6:07 p.m. on November 29, measure one-first-width 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: (Times are Central Standard Time.)

November 11, 6:00 a.m.: Launch Coverage of the Orbital ATK Antares/Cygnus resupply mission to the International Space Station. Actual launch is 6:37 CST. News conference is at 9:00 a.m.

November 13, 3:00 a.m.: coverage of rendezvous and capture of the Cygnus cargo craft.

December 13, 10:30 p.m.: Undocking coverage of the ISS Expedition Soyuz capsule. Actual undocking is at 11:12 p.m.

December 14, 1:00 a.m.: coverage of deorbit burn and landing of the ISS Expedition Soyuz capsule. Actual deorbit burn starts at 1:38 a.m., with landing at 2:32 a.m.

December 17, midnight: Launch coverage of the Expedition 54/55 Soyuz from Baikonur Cosmodrome in Kazakhstan. Pre-launch activities begin at 12:25 a.m., and actual launch is at 1:10 a.m.

December 19, 3:30 a.m.: Docking coverage of the Expedition 54/55 Soyuz and Space Station. (Actual docking is 4:18 a.m.) 5:30 a.m.: Coverage of hatch opening and welcoming ceremony. (Actual hatch opening is at approximately 6:00 a.m.)

Calendar of Events

November 8: [tentative] Oklahoma Space Industry Development Authority [OSIDA] meets at 1:30 p.m. the Oklahoma Department of Transportation Building in Oklahoma. Call 580-562-3500 to verify.

November 10: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex), 7:00 p.m., followed by a talk at 7:45 p.m. See http://www.okcastroclub.com/ for details.

November 10: Launch of an Orbital ATK resupply mission

November 11 Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

November 11: Launch of Orbital ATK resupply mission to International Space Station, 7:37 a.m.

November 17: Peak of Leonid meteor shower

November 24: Mercury is at greatest eastern elongation, 22 degrees from the Sun (so can be seen after sunset).

Early December: Launch of SpaceX resupply mission to the ISS.

December [Tentative]: First (unmanned) flight of SpaceX's Falcon Heavy rocket.

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

December 12: Mercury is in inferior conjunction with the Sun.

December 13: [tentative] Oklahoma Space Industry Development Authority [OSIDA] meets at 1:30 p.m. the Oklahoma Department of Transportation Building in Oklahoma. Call 580-562-3500 to verify.

December 14: Peak of Geminid meteor shower.

December 17: Launch of Expedition 54 to the Space Station, by Soyuz from the Baikonur Cosmodrome in Kazakhstan.

December 21: Saturn is in conjunction with the Sun.

December 21: Winter begins in Northern Hemisphere at 10:28 a.m.

December 22: Peak of Ursid meteor shower.

December 28: Launch of the Team Indus and Hakuto missions by the Indian Space Research Organisation (ISRO). These are two of the five competitors for the Google Lunar X Prize see lunar.xprize.org/teams/team-nidus and lunar.xprize.org/teams/hakuto for details.

Late in 2017: SpaceX launches SpaceIL Google Lunar X Prize Moon lander. This includes a lander and a rover. See lunar.xprize.org/teams/team-spaceil and en.wikipedia.org/wiki/Google_Lunar_X_Prize for details.

Late in 2017: Synergy Moon will use a Neptune 8 rocket to launch a lunar lander and rover as part of the Google Lunar X Prize contest. See lunar.xprize.org/teams/synergy-moon for details.

Late in 2017: Moon Express will launch one of three missions to the Moon to study lunar resources, using Rocket Lab to launch them from New Zealand. See https://lunar.xprize.org/teams/moon-express for details.

Sometime in 2018: Launch of Japan's *SELENE-2* [aka *Kaguya*] spacecraft to the Moon. This mission includes an orbiter, lander and rover. For more information, visit https://en.wikipedia.org/wiki/SELENE-2

Early 2018: India launches *Chandrayaan-2* to the Moon. The mission consists of an orbiter, lander and rover.

January 1, 2018: Mercury is at greatest western elongation, 22 degrees west of the Sun, and is visible before sunrise in the constellation Ophiuchus.

January 5, 2018: Mars is 0.2° north of Jupiter.

January 9, 2018: Venus is in superior conjunction with the Sun.

February 17, 2018: Mercury is in superior conjunction with the Sun,

March 4, 2018: Neptune is in conjunction with the Sun.

March 15, 2018: Mercury is at greatest eastern elongation, 18 degrees east of the Sun, and is visible after sunset in Pisces.

April 2018: [Moved from September 2017.] Launch of the Green Propellant Infusion Mission (GPIM) by a SpaceX Falcon Heavy rocket. This mission is "green" because the fuel it uses, hydroxylammonium nitrate produces nontoxic gases when it burns, unlike hydrazine

April 2018: [Moved from February.] Demonstration flight of SpaceX's Dragon 2 spacecraft (apparently not aboard a Falcon 9 Heavy).

April 12, 2018: Yuri's Night. 57th anniversary of the first man in space.

April 1, 2018: Mercury is in inferior conjunction to the Sun.

April 18, 2018: Uranus is in conjunction with the Sun.

April 29, 2018: Mercury is at greatest western elongation, 27 degrees west of the Sun, and is visible before sunrise in the constellation Cetus.

May 5, 2018: Launch of *InSight*, a lander that will probe the interior of Mars. For information, see http://insight.jpl.nasa.gov/.

May 9, 2018: Jupiter is at opposition, 409 million miles from Earth.

June 2018: Launch of TESS, the Transiting Exoplanet Survey Satellite. Unlike *Kepler*, TESS will conduct a full sky search for exoplanets. For information, visit space.mit.edu/TESS. [Postponed from March.]

June 6, 2018: Mercury is in superior conjunction with the Sun,

June 27, 2018: Saturn is at opposition, 840 million miles from Earth.

July 11, 2018: Mercury is at greatest eastern elongation, 26 degrees east of the Sun, and is visible after sunset in Cancer.

July 27, 2018: Mars is at opposition. This will be the closest Mars opposition since 2003, and until the 2030s although Mars is closest to Earth on July 31. Mars will be 36 million miles from Earth.

July 31, 2018: Proposed launch date for *Parker Solar Probe* (formerly *Solar Probe Plus*), which will study the corona of the Sun from within four million miles. For information, see en.wikipedia.org/wiki/Parker_Solar_Probe or http://parkersolarprobe.jhuapl.edu/. (This spacecraft will fly by Venus seven times to refine its orbit.)

August 2018: [Moved from May.] SpaceX will launch a Dragon-2 capsule to the International Space Station. This mission will be the first American spacecraft to carry people to orbit since 2011. [See August.]

August 2018: Boeing's CST-Starliner makes its first automated test flight. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

August 8, 2018: Mercury is in inferior conjunction with the Sun.

August 17, 2018: Venus is at greatest eastern elongation, 46 degrees east of the Sun, and is visible after sunset in Virgo

August 26, 2018: Mercury is at greatest western elongation, 28 degrees west of the Sun, and is visible before sunrise in the constellation Cancer.

September 7, 2018: Neptune is at opposition.

September 20, 2018: Mercury is in superior conjunction with the Sun.

October 2018: The European Space Agency/JAXA *BepiColombo* Mercury Orbiter is launched. On its way to Mercury, *BepiColombo* will make two flybys of Venus and one of Earth, and six flybys of Mercury before settling into orbit. Home page is http://sci.esa.int/bepicolombo.

October 24, 2018: Uranus is at opposition.

October 26, 2018: Venus is in inferior conjunction with the Sun.

November 2018: [Moved from August 2018.] Boeing's CST-Starliner makes its first crewed flight. If the SpaceX mission is delayed, this will be the first American spacecraft to carry astronauts to orbit since 2011, otherwise it will be the second. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

November 6, 2018: Mercury is at greatest eastern elongation, 23 degrees east of the Sun, and is visible after sunset in Scorpius

November 26, 2018: Jupiter in in conjunction with the Sun.

November 27, 2018: Mercury is in inferior conjunction with the sun.

December 7, 2018. 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 15, 2018: Mercury is at greatest western elongation, 21 degrees west of the Sun (hence is visible before sunrise), in the constellation Libra.

Late in 2018 [Moved from 2017.]: Launch of the European Space Agency's CHEOPS space telescope, which will study exoplanets which transit their star's disc. Project website is sci.esa.int/cheops.

Late in 2018: SpaceX hopes to launch two human tourists on a flight around the moon. This would be the first time humans have gone beyond low-Earth orbit since 1972.

Sometime in 2019: Maiden flight of the Space Launch System.

Spring 2019: [Moved from October 2018]: Launch of the James Webb Space Telescope.

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 1, 2019: *New Horizons* flies by Kuiper Belt object 2014 MU_{69}.

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

February 2019: Launch from Cape Canaveral of the European Space Agency/NASA Solar Orbiter (SolO), which will orbit the Sun at a distance closer than Mercury. Web site is sci.esa.int/solarorbiter

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 of ESA's *ExoMars Mars Rover*. For more information, visit en.wikipedia.org/wiki/Exomars.

July 2020: United Arab Emirates launch the Mars probe *Hope*.

July 2020: ESA launches the *ExoMars Mars Rover*. [Postponed from May 2018.] For more information, visit en.wikipedia.org/wiki/Exomars.

July 2020: Launch of the *Mars 2020* space rover, which will arrive on Mars at the beginning of 2021.

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

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

Sometime in 2022: SpaceX plans to launch a human crew around the Moon. [This is really 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.

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, 2017 (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 chapters.nss.org/ok/osanss.html. 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-mailnsshq@nss.org. The Chapters Coordinator is Bennett Rutledge 720-641-7987, rutledges@chapters.nss.org. The address is: National Space Society, PO Box 98106, Washington DC 20090-1600 Web page is 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.)
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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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