

Oklahoma Space Alliance OUTREACH

May 2017

May Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, May 13, 2017 at Earl's Rib Palace, 920 SW 25th St, Moore, OK. This is between the 1-35 West Frontage Road and Telegraph Road, a couple of blocks south of Harry Bears. Telephone number is 793-7427.

Saturday May 13 2017 Program

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

- 1) Introductions
 - a. What's Happening in Space, News, Pictures, and Videos by David Sheely
- 2) Break
- 3) **"Greening the Galaxy"** a presentation by the Oklahoma Space Alliance Chapter, National Space Society, based on the NSS Roadmap 2017 Draft. Claire McMurray will present this talk both here and at the International Space Development Conference in St Louis.
- 4) Discuss Business
 - a. Review OSA Accounts
 - b. Summary of April Meeting
 - c. Other issues
- 5) Chat

Minutes of April Meeting

Oklahoma Space Alliance held its regular monthly Meeting on April 8 at Earl's Rib Palace in Moore, Oklahoma. Attending were Steve and Karen Swift, Russ Davoren, Mike Hopkins, Tom Koszoru, Claire and Clifford McMurray, Tim Scott, Dave Sheely, Brian Swift, Rosemary Swift, Rachelle Thibodeaux, Dennis Wigley, and Syd Henderson. OSA President Steve Swift presided over the meeting.

Since this was our meeting closest to Yuri's Night, we had our Celebration of Human Space Flight at this meeting.

What's Happening in Space: (This is online as part of the April *Update*: <http://chapters.nss.org/ok/Update1704.pdf>.)

Article: "We May Have Just Witnessed the Dawn of Truly Commercial Spaceflight" by Eric Berger, <http://arstechnica.com>. The birth here is the first launch of a spacecraft into orbit by a reusable commercial rocket. We watched a video of this launch and landing by SpaceX.

NASA now has a searchable online library full of pictures, located at <https://images.nasa.gov>.

Jupiter has a co-orbital asteroid that orbits retrograde with respect to Jupiter's orbit. This means that it passes through both clouds of Trojan asteroids and comes close to Jupiter as well.

We watched the Delta IV launch of WSG 9.

Business Meeting:

We have \$1083.38 in the checking account and \$257 in cash. We voted to reimburse Steve for the cost of dessert for the Celebration.

Rachelle is graduating from UCO.

Celebration of Space Flight.

We watched a few-seconds long video of Yuri Gagarin's launch.

We watched a video of Gagarin with a photographic tour of his house.

We watched a video of John Glenn's first orbital flight.

We watched a video of space launch facilities.

We watched a video of American launch failures, many (but not all) of which occurred before Alan Shepard's launch.

We watched a video of Neil Armstrong on an Australian talk show.

Claire has permission to say that "Greening the Galaxy" is from Oklahoma Space Alliance.

We had desserts to celebrate space flight.

--Minutes by OSA Secretary Syd Henderson

Photos from Yuri's Night Celebration





Space News

The *Cassini* spacecraft is in the process of ending a spectacular 20-year mission with a series of “Grand Finale” orbits, the first of which, on April 22, saw it become the first spacecraft to pass between Saturn and its rings. The Grand Finale will end at 4:44 p.m. on September 15, when *Cassini* takes a farewell dive into Saturn’s atmosphere.

When *Cassini* finally dies, there will be no space probes visiting the planets beyond Jupiter for at least a decade, though *New Horizons* will be visiting a Kuiper Belt object on New Year’s Day, 2019. NASA has been taking proposals for the New Frontiers program, to which *New Horizons*, *Juno* and *OSIRIS-Rex* belong, and these do include a Saturn Probe and a probe of Saturn’s satellites. We won’t know which of these will be selected until at least November.

One problem is that we have only recently resumed plutonium-238 production, and nuclear power is essential for missions travelling beyond Jupiter. *Juno* is the first Jupiter probe to use solar arrays, and it has the largest arrays ever on a planetary probe, and even so they produce less than a kilowatt of power.

At closest approach, *Cassini* was less than 2000 miles from the top of Saturn’s clouds, and two hundred miles from the inner edge of the wispy D-Ring. Earlier in the orbit, it flew 600 miles from Titan, which gave *Cassini* the gravitational assist it needed to enter its new, highly elliptical orbit.

Cassini’s first flyby in its Grand Finale produced one major surprise: It was expected that it would encounter a large number of dust particles while passing between Saturn and the D-Ring, but in fact, it encountered hardly any at all. The space between Saturn and the D-Ring is now nicknamed “The Big Empty.”

China premiered its Tianzhou spacecraft with a launch to the Tiangong-2 Space Station on April 20, with a successful docking on April 22. Tianzhou is actually a modified Tiangong spacecraft, and is designed to resupply Tiangong-2 and eventually the large Tiangong-3 space station. Tianzhou is capable of carrying six metric tons of supplies to the space stations. The current Tianzhou will remain connected to Tiangong for two months to test refueling and joint maneuvers, which will include two additional dockings.

China is also planning to launch a lunar sample return mission in November. The Chang’e 5 mission will include an orbiter and a lander. The last spacecraft to return lunar material was *Luna 24* in 1976.

In a refreshing change from all the exoplanets being discovered orbiting a few million miles from their star, OGLE, the Optical Gravitational Lensing Experiment, has discovered a planet that is not only about the mass of Earth, but also the same distance from its star. Unfortunately, the star, which rejoices in the OGLE-2016-BLG-1195L, has only 7.8% of the mass of the Sun, which means that, assuming the planet has water at all, it is frozen solid. Actually, with a mass that small, the star is at the borderline between being a red dwarf star and a brown dwarf.

The star, by the way, is 13,000 light-years away, which makes it amazing that OGLE observed it at all. It found the star, and later the planet, through gravitational lensing, which bent the light of a more distant star, making it brighten twice, first from the gravity of the star, then from the gravity of the planet.

SpaceX is testing an onboard autonomous control system for its Falcon 9 rocket that will be able to monitor its flight and, if the rocket veers dangerously off-course, destroy it. The system is called the AFSS (Automated Flight Safety System), and was developed in conjunction with the military, FAA and NASA.

First use was on a February 19 launch of a Falcon 9 to the Space Station, replacing a ground crew of range spotters. The AFSS allows SpaceX to cut the crew required for a launch by more than half, which, of course, is a considerable cost saving, one which SpaceX will need in the near future when it plans for a launch every week, and SpaceX plans to use it on all future flights,

Now that the AFSS has been developed, other companies such as the United Launch Alliance can also use it, and it will use one on its Vulcan rockets, and Orbital ATK is working with the Air Force to get an AFSS for its rockets. However, America is late in developing the technology—some Russia rockets, for instance, have been able to autonomously terminate for at least a decade.

[“Safe Destruction,” by Irene Klotz, *Aviation Week & Space Technology*, March 20 – April 2, 1977, pp. 37 -38 and sources online.]

The European Space Agency has chosen two possible landing sites for the *ExoMars* Mars Rover, which will launch in July 2020. Oxia Planum is located not far from the “mouth” of the Valles Marineris and east of Chryse Planitia. Chryse is up to two miles lower than the average altitude of Mars and Oxia Planum is only a thousand feet higher. The other site, Mawrth Vallis, is only a couple of hundred miles east of Oxia Planum, but still well below the average altitude of Mars. These two sites were chosen because it is believed the region was once under water and is full of clays, and there is evidence that rivers used to flow in the region.

If Chryse Planitia sounds familiar, it is where the *Viking 1* lander set down on Mars, but it landed in an area with more volcanic rock. The *Mars Pathfinder* landed at the mouth of Ares Vallis about three hundred miles west of Oxia Planum.

Przybylski’s Star (HD 101065, or V816 Centauri), is a variable star of type Ab that is unusual in that its spectrum indicates contains high amounts of heavy metals, not just the rare earths, thorium and uranium, but short-lived transuranic elements all the way to lawrencium (element 103), Vladimir Dzuba of the University of New South Wales and his team are studying the star to see whether it might contain even heavier elements, those in the Island of Stability that is supposed to occur somewhere around atomic number 114 (flerovium) and 184 neutrons. Isotopes with atomic numbers 120 and 126 (the undiscovered unbinilium and unbihexium) and 184 protons are also predicted to be unusually stable. If the spectra associated with those atomic numbers are found in the atmosphere of Przybylski’s star, it may indicate that there is hope that we may find some ultramassive isotopes that may hang around for a few million years. (Note though, that the heaviest isotope of flerovium yet produced has mass 290, and they’re looking for mass 298.)

Sky Viewing

Jupiter was at opposition on April 8, and, at magnitude -2.4, is still dominating the sky from sunset until early morning (except when the Moon is up, or the ISS is high in the sky). Jupiter is moving back and forth through the constellation Virgo about ten degrees above the first-magnitude star Spica. Jupiter appears in retrograde motion until June 8, and will pass the star Gamma Virginis a couple of times in June.

Saturn is currently magnitude 0.2 and rising around 10:30 p.m. Like Jupiter, it is in retrograde motion, in this case moving back across the constellation Sagittarius. Saturn will brighten later in May and reach magnitude 0.0 when it is at opposition on June 15. This is not far from the maximum possible brightness for Saturn (-0.3), and it is much brighter than any stars in that region of the sky. One reason it is so bright, is, naturally, because the rings are near their maximum tilt. In other words, this is about the best possible time to be viewing Saturn.

Venus is currently shining at magnitude -4.7 low in the eastern sky before dawn. Venus is past inferior conjunction, and approaching greatest elongation on June 3, at which point it will be rising two hours before the Sun. Later in June, it will be rising ever earlier with respect to the Sun because of the angle of the ecliptic with the horizon.

Mercury has such a quick orbit that it is currently hidden in twilight, will reach greatest western elongation on May 17 (which, since it is only four degrees above the horizon at the beginning of twilight, is a mixed blessing), at which time

it will be magnitude 0.4, brighten to magnitude -.4 at the beginning of June (while still being the same height above the horizon), then move swiftly to superior conjunction with the Sun on June 21. In other words, it's a challenge if you don't use binoculars.

Mars is only magnitude 1.6 and low in the western sky at sunset, so will be difficult to see. Mars will be slowly disappearing further into twilight each night, finally disappearing in early June. Since Mars's orbit is close to Earth, it's a long time between conjunctions (about two years, like with oppositions), and when it nears one, it vanishes for a long time compared with the outer planets. Mars won't actually be in conjunction with the Sun until July 27, and won't be visible again until September.

Uranus and **Neptune** are both two buried in twilight to be visible even through binoculars. However, in June, Neptune will be rising several hours before the Sun. *Astronomy* suggests using the Great Square of Pegasus as a guide. Beta and Alpha Pegasi are the two stars on the western side of the Square. If you imagine a line from Beta to Alpha Pegasi (i.e. southward) and extend it twice further, you'll be looking in the vicinity of Neptune. However, since it is magnitude 7.9, you'll need a good pair of binoculars to see it. **Uranus** will be rising near the end of twilight in early June. However, it may be findable with binoculars since it will be only two degrees northwest of Venus.

[Information for this section from the May and June issues of *Astronomy* and *Sky & Telescope*, and www.skyandtelescope.com.]

Space-Related Articles:

"Getting Up There," by Frank Moring, Jr., and Lara Seligman, *Aviation Week & Space Technology*, April 17 – 30, pp. 20-21. Subtitled "U.S. Air Force fuels emerging generation of launch vehicles," this article is about the competition of various commercial space companies for the lucrative military space market. These include the usual suspects, SpaceX and the United Launch Alliance (who are the source of a competition between Blue Origin and Aerojet Rocketdyne to produce their new engine), and Orbital ATK. Blue Origin is ahead of Aerojet Rocketdyne in the ULA competition, but Aerojet Rocketdyne expects to be ready by 2019. SpaceX and Orbital ATK, of course, are already resupplying the Space Station with orbital spacecraft. ULA has been relying on Atlas rockets and Russian RD-180 engines and are anxious for a new engine to power its Vulcan spacecraft.

[SpaceX actually is new to this game, too. On May 1, it launched a classified satellite for the National Reconnaissance, ending the ULA's decade-long monopoly as a commercial space company launching military and reconnaissance payloads. SpaceX will launch two GPS satellites for the Air Force in the next couple of years, then compete with the ULA when the latter's contract runs out in 2019.

Oh, and SpaceX also landed the first stage back on the original launch pad.]

Viewing Opportunities for Satellites (May 12 to June 12, 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.

<http://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. 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. SpaceX launches a cargo mission to the Station on June 1. The next manned launch to the Station isn't until July. I know of no scheduled manned flights to Tiangong 2; however, China docked a Tianzhou unmanned cargo spacecraft with Tiangong 2 on April 22, and might be expected to do more such tests.

Tiangong 1 May 14, 2017

Time	Position	Elevation
9:32 p.m.	294°	10°
9:35	209	76
9:36	127	28

Vanishes into Earth's shadow

HST May 17, 2017

Time	Position	Elevation
5:57 a.m.	227°	20°
5:58	208	27
5:59	188	31
6:00	154	27
6:01	135	20

HST May 18, 2017

Time	Position	Elevation
5:47 a.m.	229°	20°
5:48	210	26
5:49	184	30
5:50	157	26
5:51	138	20

HST May 19, 2017

Time	Position	Elevation
5:37 a.m.	231°	19°
5:38	212	25
5:39	186	29
5:40	160	25
5:41	141	19

Tiangong 2 May 20, 2017

Time	Position	Elevation
Appears from Earth's shadow		
4:52 a.m.	299°	17°
4:55	25	84
4:58	116	10

Tiangong 2 May 23, 2017

Time	Position	Elevation
9:38 p.m.	234°	10°
9:41	151	69
9:44	67	10

ISS May 23, 2017

Time	Position	Elevation
9:52 p.m.	206°	20°
9:53	192	37
9:54	135	55
9:55	77	37
9:56	63	21

ISS May 25, 2017

Time	Position	Elevation
5:07 a.m.	311°	22°
5:08	310	43
5:09	207	87
5:10	135	41
5:11	134	21

Tiangong 2 May 25, 2017

Time	Position	Elevation
9:16 p.m.	253°	10°
9:19	335	64
9:22	58	10

ISS May 25, 2017

Time	Position	Elevation
9:45 p.m.	252°	20°
9:46	269	35
9:47	321	50
9:48	13	35
9:49	30	20

HST June 1, 2017

Time	Position	Elevation
10:13 p.m.	229°	20°
10:14	210	26
10:14:59	183	30
10:15:40	164	28

Vanishes into Earth's shadow

HST June 2, 2017

Time	Position	Elevation
10:03 p.m.	230°	19°
10:04	211	26
10:05	185	29
10:06	159	26

Vanishes into Earth's Shadow

Tiangong 1 June 6, 2017

Time	Position	Elevation
5:36 a.m.	246°	10°
5:39	334	80
5:41	61	10

Tiangong 2 June 3, 2017

Time	Position	Elevation
10:00 p.m.	298°	10°
10:03	26	81
10:04:45	110	32

Vanishes into Earth's shadow

Tiangong 1 June 8, 2017

Time	Position	Elevation
Appears from Earth's shadow		
4:43:12 a.m.	258°	49°
4:43:48	323	78
4:47	61	10

ISS June 10, 2017

Time	Position	Elevation
10:22 p.m.	336°	18°
10:23	320	42
10:24:26	47	81
10:25:06	119	53

Vanishes into Earth's shadow

ISS June 11, 2017

Time	Position	Elevation
9:30 p.m.	336°	18°
9:31	356	30
9:32	38	38
9:33	79	29
9:34	98	18

ISS June 13, 2017

Time	Position	Elevation
9:22 p.m.	307°	22°
9:23	301	42
9:24	219	77
9:25	146	41
9:26	140	21

Key: Position is measured in degrees clockwise from north. That is, 0° is due north, 90° is due east, 180° is due south, and 270° is due west. Your fist held at arm's length is about ten degrees wide. "Elevation" is elevation above the horizon in degrees. Thus, if you have insomnia and want to see Tiangong 1 appear on June 8, measure about one fist-width south of due west, then five 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>

Not much on the NASA TV Schedule this month, but SpaceX will be launching a resupply mission to the Space Station on June 1, and I'm sure that NASA TV will cover at least the docking.

Calendar of Events

May 12 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.

May 13: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

May 17: Mercury is at greatest western elongation, 26 degrees from the Sun (so can be seen before sunrise).

May 29: Launch of Expedition 52/53 to the Space Station.

No earlier than June: ICON (the Ionosphere Connection Explorer) is launched from Kwajalein Atoll by Orbital ATK.

June 3: Venus is at greatest western elongation, 46 degrees from the Sun (so can be seen before sunrise).

June 9: 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.

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

June 14: [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.

June 15: Saturn is at opposition.

June 19: Mercury is in superior conjunction with the Sun.

July 8: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

July 12: [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.

July 14: 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.

July 20: 48th anniversary of the *Apollo 11* landing on the Moon.

July 27: Mars is in conjunction with the Sun.

July 30: Mercury is at greatest eastern elongation, 27 degrees from the Sun (so can be seen after sunset).

August: First crewed demo flight of SpaceX's Dragon 2 Spacecraft.

August 11: 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.

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

August 12: Peak of Perseid meteor shower.

August 21: The next total solar eclipse visible in the United States, on a pretty straight path from Portland, Oregon to Charleston, South Carolina. St. Louis is the biggest city in-between.

August 26: Mercury is in inferior conjunction with the Sun.

September 5: Neptune is at opposition.

September 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.

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

September 12: Mercury is at greatest western elongation, 18 degrees from the Sun (so can be seen before sunrise).

September 15: The *Cassini* spacecraft will end its mission with a plunge into Saturn's atmosphere.

September 30: [Moved from March.] 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

September 30: Launch of Expedition 53/54 to the Space Station.

October 4: 60th anniversary of the launch of *Sputnik 1*, the first spacecraft to orbit the Earth.

October 8: Mercury is at superior conjunction with the Sun.

October 11: Peak of Orionid meteor shower.

October 14: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., Earl's Rib Palace in Moore, Oklahoma.

October 19: Uranus is at opposition.

October 26: Jupiter is in conjunction with the Sun.

November: 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.)

November: Launch of Expedition 54/55 to the Space Station.

November: First (unmanned) flight of SpaceX's Dragon 2 Spacecraft. Dragon 2 which will be the first commercial spacecraft capable of carrying humans to orbit (as well as the first human-rated space vehicle capable of making a soft landing on Earth.) This flight will take it to the Space Station.

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

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).

December: 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>.

December: Proposed launch of TESS, the Transiting Exoplanet Survey Satellite. Unlike *Kepler*, TESS will (if approved) conduct a full sky search for exoplanets. For information, visit space.mit.edu/TESS.

December 13: Mercury is in inferior conjunction with the Sun.

December 14: Peak of Geminid meteor shower.

December 21: Saturn is in conjunction with the Sun.

December 22: Peak of Ursid meteor shower.

Late in 2017: SpaceX launches the Google Lunar X Prize Moon landing. This includes a lander and a rover. See <http://lunar.xprize.org/> and en.wikipedia.org/wiki/Google_Lunar_X_Prize for details.

Sometime in 2018: Possible unmanned SpaceX mission to Mars.

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

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

May 2018: 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.]

May 5, 2018: Launch of *InSight*, a lander that will probe the interior of Mars. For information, see <http://insight.jpl.nasa.gov/>. [Postponed from March 2016.]

June 2018: Orbital test flight of Boeing's CST-100 Starliner, which will be capable of carrying humans to orbit. See http://en.wikipedia.org/wiki/CST-100_Starliner for details.

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

August 2018: Boeing's CST-Starliner makes its first crewed flight. If the May SpaceX mission is delayed, this will be the first American spacecraft to carry astronauts to orbit since 2011, otherwise it will be the second.

October 2018: Earliest date for the launch of the James Webb Space Telescope.

October 2018: The European Space Agency/JAXA *BepiColombo* Mercury Orbiter is launched. Home page is <http://sci.esa.int/bepicolombo>.

October 2018: 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. [Moved from July 2017.]

December 2018: Boeing's CST-100 Starliner carries two astronauts to the Space Station. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

Late in 2018: SpaceX plans to launch a human crew around the Moon.

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

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/>.

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: First launches of the modules of the Chinese space station *Tiangong-3*. The station should be finished by 2022.

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.

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>.

December 19, 2024: *Solar Probe Plus* makes its first pass through the outer corona of the Sun. [See July 31, 2018.]

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. 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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David Sheely, Vice President	821-9077 (C)
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Tim Scott, Treasurer	740-7549 (H)
Claire McMurray, Communications	329-4326 (H) 863-6173 (C)

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cliffclaire at hotmail.com (Claire McMurray)

sydh at ou.edu (Syd Henderson)

ctscott at mac.com (Tim Scott)

t_koszoru01 at cox.net (Heidi and Tom Koszoru, new address)

sheely at sbcglobal.net or david.sheely.1 at us.af.mil (David Sheely)

john.d.northcutt1 at tds.net (John Northcutt)

lensman13 at aol.com (Steve Galpin)

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-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

_____ TOTAL amount enclosed

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?

_____ Yes _____ No. [See brochure for information.]

Name _____

Address _____

City _____ State ___ ZIP _____

Phone (optional or if on phone tree) _____

E-mail address (optional) _____

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.**

OKLAHOMA SPACE ALLIANCE

OUTREACH – May 2017

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet
2:00 p.m. on May 13, 2017
at Earl's Rib Palace,
920 SW 25th St, Moore, OK.
Directions are inside.



**Cassini Begins Grand Finale. (See Page 4)
Picture credit: NASA Artist's Conception**