

Oklahoma Space Alliance OUTREACH

March 2017

March Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, March 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, a couple of blocks south of Harry Bears. Telephone number is 793-7427.

Saturday March 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 January Meeting
 - c. Yuri's Night Plans
 - d. ISDC plans
- 4) Feature video
- 5) OSIDA Meeting Report (The OSIDA meeting has been moved to Tuesday, March 14)
- 6) Chat

Minutes of February Meeting

Oklahoma Space Alliance held its regular monthly Meeting on February 11 at Earl's Rib Palace in Oklahoma City. Attending were Steve and Karen Swift, Russ Davoren, Mike Hopkins, Claire and Clifford McMurray, Don Robinson, Tim Scott, Dave Sheely, Brian Swift, Chris (last name unknown), Dennis Wigley, and Syd Henderson, OSA president Steve Swift presided over the meeting, leading off with What's Happening in Space. This is online at <http://chapters.nss.org/ok/osanss.html> as part of the February *Update*. We added to the agenda that the Stafford Museum in Weatherford is having an exhibit called 'Hidden Treasures.'

We watched a trailer for the movie *Hidden Figures* about three black women struggling for recognition during the early years of NASA. (Actually the real story would include about a decade NASA's predecessor NACA which is when Dorothy Vaughan began, though the movie understandably condensed the timeline.)

We watched a video of the January 20 launch of the third Space-Based Infrared System to geosynchronous orbit, on an Atlas V by the United Launch Alliance.

We saw some of the first photographs taken by the GOES-16 Weather satellite which was launched in January.

Launchpad 39A at Cape Canaveral saw the launches of *Apollo 11* and eighty shuttle missions. SpaceX will launch from the same pad on February 18.

Cliff: Dreamchaser can bring cargo back at lower G and land on a runway.

Elon Musk's Tesla is building a gigantic factory to produce batteries that will double world production of his kind of batteries.

We have \$1045 in the bank account and \$267 in cash.

Mike Hopkins joined OSA.

Chapters want donations for Chapter room at ISDC. Will be for NSS members only. [We're seeking to change that.]
Claire went through a Power Point slideshow of her presentation of the NSS Roadmap.

[The February OSIDA meeting was cancelled and the March meeting moved to March 14, so no OSIDA notes this month.]

--Minutes by OSA Secretary Syd Henderson

Space News

The most startling announcement of the month is that TRAPPIST-1, a tiny star already known to have a couple of planets, actually has seven planets comparable in size to Earth, three of which at least are within its habitable zone. Here are some data from Wikipedia:

| Planet | Period (days) | Orbital radius (AU) | Radius/Earth | Mass/Earth |
|--|---------------|---------------------|--------------|------------|
| b | 1.51 | .011 | 1.09 | 0.85 |
| c | 2.42 | .015 | 1.06 | 1.38 |
| d | 4.05 | .021 | 0.77 | 0.41 |
| e | 6.10 | .028 | 0.92 | 0.92 |
| f | 9.21 | .037 | 1.04 | 0.68 |
| g | 12.35 | .045 | 1.13 | 1.34 |
| h | 20 (est) | .06 (est) | 0.76 | ? |
| Comparable numbers for the inner solar system: | | | | |
| Mercury | 88 | 0.39 | 0.38 | 0.06 |
| Venus | 224.7 | 0.72 | 0.95 | 0.82 |
| Earth | 365.26 | 1 | 1 | 1 |
| Mars | 687 | 1.52 | 0.53 | 0.1 |

Although all seven planets are much closer to TRAPPIST-1 than Mercury is to the Sun, TRAPPIST-1 is only 0.0004 as bright as the Sun and has a surface temperature around 2550 degrees Kelvin, compared to about 5800 degrees for the Sun. TRAPPIST-1 has only about eight percent of the Sun's mass, which is probably still sufficient to lock the rotations of the planets. I note that the planets are almost in 3/2 orbital resonances as you go out. This is particularly striking for planets d, e, f and g. Note that resonances like this are what heats up the interiors of Io and Europa.

Since TRAPPIST-1 is so cool, it is deeply red, and since red dwarfs like Proxima and TRAPPIST-1 can shine for trillions of years, it's rather surprising that TRAPPIST-1 appears to be a fairly young star. "Young" in this case is a relative term: it must be at least a half-billion years old to be stable as a red dwarf. Its youth is indicated because it gives off as many X-rays as Proxima Centauri while only giving off a sixth as much ultraviolet light. This ratio goes down as a star ages. TRAPPIST-1 also rotates once every day and a half, which is fast for a star. The rotation period drops as stars age, I believe because their stellar winds take away their angular momentum. (Although it could be that TRAPPIST-1 simply doesn't have much of a stellar wind.)

Although TRAPPIST-1 is still pretty dim in the ultraviolet, there may still be enough to strip the atmospheres from the innermost planets. At least there is no indication that it is a flare star.

Another unusual solar system is that of the binary "star" SDSS 1557. Star is in quotes here, because one is a white dwarf and the other a brown dwarf (that is, a star-like object that's too small to fuse protons into helium). The white dwarf is eating metallic asteroids, which may mean the rocky asteroids in the system may have coalesced into rocky planets.

On February 27, SpaceX announced another radical plan, this time to launch two astronauts in a Dragon capsule on a trip around the Moon sometime around the end of 2018. This would beat NASA's Orion spacecraft by more than two years, and is ambitious considering that SpaceX won't be launching any astronauts before May 2018. The big questions aren't the launch capacity, since Falcon 9 Heavy will certainly be able to launch a Dragon 2 capsule to the Moon (and eventually to Mars), but life support for the week-long flight, and the risks associated with what is a pretty new vehicle.

The date is significant, because, if successful, it would take place almost exactly 50 years after Apollo 8 became the first manned spacecraft to orbit the Moon.

The *Dawn* spacecraft has detected substantial amounts organic molecules in the northern hemisphere of Ceres. The compounds appear to be aliphatic (i.e., they don't have rings). The organic molecules appear to have been brought up by ice volcanoes. Organics and water are the ingredients of life, of course, but Ceres is probably too cold for that and doesn't have an atmosphere.

NASA has chosen three possible landing sites for the Mars 2020 rover, Jezero Crater and northeast Syrtis Major, which are close together just north of the Martian equator, and Columbia Hills, which is close to where *Spirit* is located. All three are places where water is suspected to have flowed, and are places to search for indications that Mars may once have harbored life. Jezero Crater is full of what appear to be dried-up river channels, while northeast Syrtis Major features a large shield volcano which presumably warmed up the soil around there enough to keep water liquid. Columbia Hills was discovered to be the site of ancient hot springs, and probably a large lake, evidence of which was found by *Spirit*. It does seem odd that NASA's considering revisiting the area, but the Mars 2020 rover would at least get to visit the older rover.

The Mars 2020 rover will resemble *Curiosity* in appearance, and arrive the same way, by sky crane.

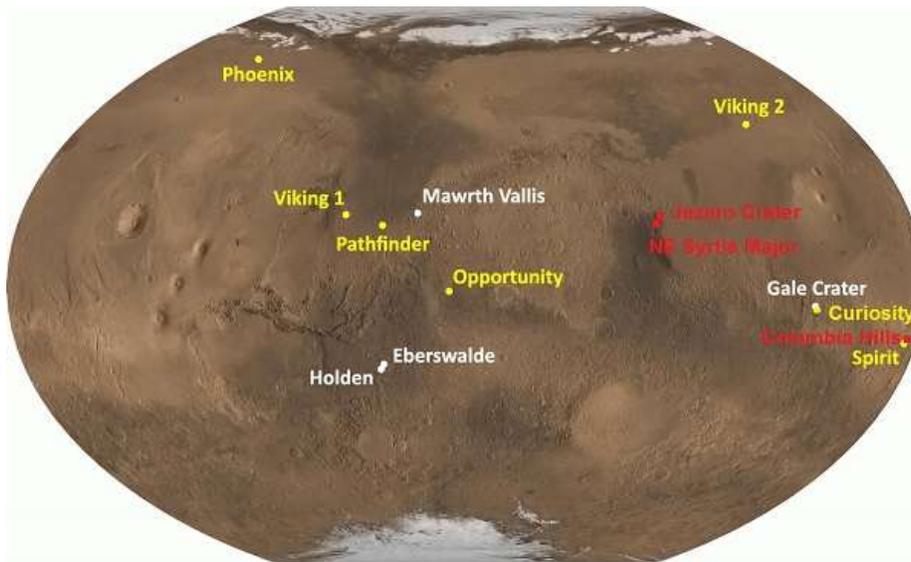


Figure 1: Martian Landing Sites, Past and Possible (NASA/JPL)



Figure 2: The Syrtis Major Shield Volcano (NASA)



Figure 3: Mars 2000 Rover (NASA)

On February 14, the California based company Planet launched eighty-eight satellites on a single Indian rocket. Combined with the satellites they already have in orbit, this brings up the total of these small satellites, known as “Doves,” to 144. The satellites will map the entire Earth daily to a resolution of 3.7 meters, giving scientists a large data set to observe transformations on the Earth as they happen. [“Planet Earth to get a daily selfie,” by Mark Strauss, *Science*, 24 February 2017, pp. 782 – 783.

It appears that Earth’s water may have arrived earlier than previously thought. The idea was when the Earth first formed, “iron-loving” metals such as nickel, platinum and its relatives, gold and rhenium dissolved in the molten iron that eventually formed the Earth’s core, and most of what is now in the crust came from space. The later asteroids and comets would have come from the outer Solar System dominated by light materials including water, which came from this later bombardment phase. However, it now appears that the ratios of isotopes of elements found in meteors and comets are inconsistent with this theory, indicating that Earth already had lots of water arriving well before the late bombardment, which in turn means that asteroids and comets from the outer solar system may not be as good a model of conditions in the inner Solar System as we thought.

On March 2, a tiny asteroid flew within 9000 miles of the Earth’s surface. However, since it was only ten feet across, it would probably just burn up if it ever hit the atmosphere.

Sky Viewing

There’s a chance we may have a naked eye comet from late March to May. **Comet 41P/Tuttle-Giacobini-Kresak** should reach magnitude 7 and might even reach fifth magnitude, in which case it would be visible in dark skies. It’s in a good position, too, crossing the Big Dipper, the bowl of the Little Dipper, and the head of Draco. There’s a star map on page 42 of the April issue of *Astronomy*.

The **Lyrid** meteor shower will peak on the morning of Saturday, April 22 starting around midnight. It’s expected that there will be 12 – 20 meteors per hour. These meteors appear to radiate from the vicinity of the star Vega, which is one of the brightest stars in the sky. The Moon will be a thin crescent and not rise until about 4:00 a.m., so it won’t be a factor while you seek the meteors.

Venus is still a brilliant magnitude -4.5 in the western sky at midnight, which it dominates for an hour and a half after sunset, and is easily visible immediately after sunset before the sky gets really dark. It’s noticeably lower in the sky each night, and will disappear entirely in a week as it approaches inferior conjunction on March 25. At the moment, Venus is a fairly thin crescent when viewed through a telescope, but makes up for it somewhat because it’s also getting closer to the Earth. Venus will become a morning star when it reappears around April 1. By the end on April, Venus will be rising an hour and a half before the Sun and is restored to magnitude -4.7.

Venus leaving the evening sky leaves **Jupiter** to rule, which it does in style, rising about the time Venus sets, and, at magnitude -2.4, is almost at maximum brightness. Jupiter is at opposition on April 8 (about 2 a.m.), so will essentially be visible all night long for the next two months. The bright star to its lower is Spica, the first-magnitude star in Virgo.

Mercury is in superior conjunction on March 6, and won't become visible until around March 20. By March 25, Mercury will be about ten degrees above the horizon a half-hour after sunset and somewhere around magnitude -1. It reaches its highest altitude around April 1, when it is 13 degrees above the horizon. It will be around magnitude 0.0. This is the best appearance for Mercury during 2017.

Mars is only magnitude 1.4, but it is still visible about twenty degrees above and to the left of Venus. Mars will be setting around ten p.m. through April, growing gradually dimmer as it moves away from the Earth. At the moment, Mars is in Aries, but will move into Taurus on April 12, where it will get to compete with Aldebaran later in the month. Aldebaran, surprisingly, is a half-magnitude brighter. Still, Mars will be visible in the evening sky through the end of Spring since it doesn't reach conjunction with the Sun until July 26.

Saturn is currently rising about 3:00 a.m., and is magnitude 0.5 in the southern part of the constellation Ophiuchus moving into Sagittarius. This isn't a particularly bright region of sky (a reason Ophiuchus isn't part of the Zodiac despite the Sun passing through it), but it stands to the left of Antares and to the upper right of the Teapot asterism in Sagittarius. Later in the month, Later in March and during April, Saturn will be moving across the Milky Way in Sagittarius—and back again, since Saturn will be going in retrograde motion on April 7. This suggests Saturn is close to opposition, but that doesn't happen until June.

Neptune was in conjunction with the Sun on March 2 and won't be observable this month and will be hard to observe in April. **Uranus** can still be seen through binoculars just after sunset and will in conjunction with the Sun on April 16, hence can't be seen in April.

[Information in this section comes from the March and April issues of *Sky & Telescope* and *Astronomy* and their websites.]

Space-Related Articles:

“Near Light-Speed Mission to Alpha Centauri,” by Ann Finkbeiner, *Scientific American*, March 2017, pp. 30 – 37. A few months ago, we heard of a proposal to launch a flotilla of mini-satellites on light sails to Alpha Centauri, using an array of lasers to accelerate them to 20% of the speed of light, enabling them to make a quick flyby twenty years after launch. The project is the brainchild of Russian-born entrepreneur Yuri Milner, and has gotten the attention of scientists like Stephen Hawking and Freeman Dyson (though Dyson would rather use them for exploring the Solar System.) The idea, incidentally, is similar to Robert Forward's Starwisp's proposed thirty years ago, but technology has advanced enough to make them almost feasible, although the construction of the giant array of lasers would seem to be constrained by economic and scientific considerations.

The proposal has received an extra incentive with the discovery of a planet orbiting Proxima Centauri, though skeptics wonder what worthwhile science can be done by such a quick fly-by of an entire planetary system.

The Starchip would be about fifteen millimeters wide, yet would have to carry a camera, power itself, have some processing power and somehow, perhaps with the aid of the light-sail, transmit a signal that could be received four light-years away. Not to mention, they have to survive being shot by the beams from the giant lasers, which means the material of which the light-sails are made must reflect 99.999% of the light hitting it, not only to use the laser light efficiently for acceleration, but to keep from burning up. Then there's the problem of hitting space dust at 20% of the speed of light, which is one reason the proposal calls for launching hundreds if not thousands of the Starchips.

When Jeanette Epps is launched to the Space Station in May of 2018, she will, incredibly, be the first African-American crewmember of the Space Station. Apparently, although African-Americans have been to the Space Station (Joan Higginbotham and Stephanie Wilson, for example), none has stayed aboard as part of the crew.

Viewing Opportunities for Satellites (March 11 to April 11, 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. There's an Orbital ATK cargo launch to the Space Station on March 19, but no manned launches until April 20. SpaceX will be launched the Neutron Star Interior Composition Explorer (NICER) on April 9. There are no launches scheduled for Tiangong 2 during this time period.

The Hubble Space Telescope has no good viewing opportunities during this time period, so I put in a few from mid-April.

Tiangong-2 March 14, 2017

| Time | Position | Elevation |
|-----------------------------|----------|-----------|
| Appears from Earth's Shadow | | |
| 7:04 a.m. | 259 | 12° |
| 7:07 | 337 | 54 |
| 7:10 | 56 | 10 |

Tiangong-1 March 15, 2017

| Time | Position | Elevation |
|------------------------------|----------|-----------|
| 8:41 p.m. | 252° | 10° |
| 8:44 | 335 | 65 |
| 8:46 | 51 | 26 |
| Vanishes into Earth's shadow | | |

ISS March 20, 2017

| Time | Position | Elevation |
|-----------|----------|-----------|
| 7:13 a.m. | 318° | 20° |
| 7:14 | 325 | 41 |
| 7:15 | 48 | 76 |
| 7:16 | 118 | 42 |
| 7:17 | 125 | 22 |

ISS March 23, 2017

| Time | Position | Elevation |
|-----------------------------|----------|-----------|
| Appears from Earth's shadow | | |
| 6:13:03 a.m. | 309° | 29° |
| 6:13:37 | 306 | 42 |
| 6:15 | 211 | 83 |
| 6:16 | 140 | 42 |
| 6:17 | 137 | 22 |

Tiangong-2 March 26, 2017

| Time | Position | Elevation |
|-----------------------------|----------|-----------|
| Appears from Earth's Shadow | | |
| 6:10 a.m. | 308° | 29° |
| 6:12 | 25 | 69 |
| 6:15 | 109 | 10 |

Tiangong-1 March 26, 2017

| Time | Position | Elevation |
|------------------------------|----------|-----------|
| 8:16 p.m. | 302° | 10° |
| 8:17 | 24 | 62 |
| 8:18 | 106 | 41 |
| Vanishes into Earth's shadow | | |

ISS March 27, 2017

| Time | Position | Elevation |
|-----------|----------|-----------|
| 8:57 p.m. | 232° | 22° |
| 8:58 | 237 | 42 |
| 8:59 | 318 | 80 |
| 9:00 | 39 | 41 |
| 9:01 | 44 | 21 |

Tiangong-2 April 3, 2017

| Time | Position | Elevation |
|------------------------------|----------|-----------|
| 8:57 p.m. | 239° | 10° |
| 9:00 | 152 | 81 |
| 9:02 | 67 | 25* |
| Vanishes into Earth's Shadow | | |
| *Passes through Orion's belt | | |

Tiangong-2 April 5, 2017

| Time | Position | Elevation |
|-----------|----------|-----------|
| 8:31 p.m. | 256° | 10° |
| 8:35 | 336 | 57 |
| 8:38 | 57 | 10 |

HST April 15, 2017

| Time | Position | Elevation |
|------------------------------|----------|-----------|
| 9:27 p.m. | 224° | 20° |
| 9:28 | 205 | 27 |
| 9:28:54 | 178 | 31 |
| 9:29:30 | 160 | 29 |
| Vanishes into Earth's shadow | | |

HST April 16, 2017

| Time | Position | Elevation |
|------------------------------|----------|-----------|
| 9:17 p.m. | 227° | 20° |
| 9:18 | 208 | 27 |
| 9:19 | 181 | 31 |
| 9:20 | 153 | 27 |
| Vanishes into Earth's shadow | | |

HST April 17, 2017

| Time | Position | Elevation |
|-----------|----------|-----------|
| 9:07 p.m. | 229° | 20° |
| 9:08 | 210 | 27 |
| 9:09 | 184 | 30 |
| 9:10 | 157 | 27 |
| 9:11 | 139 | 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 Space Station appear at 6:13 a.m. on March 23, you would measure just under four fist-widths north of due west, then three 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>

Calendar of Events

March 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.

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

March 14: Oklahoma Space Industry Development Authority [OSIDA] meets at 2:00 p.m., in the Commission Room at the Oklahoma Department of Transportation Building in Oklahoma. Call 580-562-3500 to verify.

March 19: Orbital ATK resupply mission launched to the space station.

March 25: Venus is in inferior conjunction with the Sun.

April 1: Mercury is at greatest eastern elongation, 24 degrees from the Sun (so can be seen after sunset).

April 8: Oklahoma Space Alliance meeting, time and place to be announced. This would also be our day to celebrate Yuri's night.

April 8: Jupiter is at opposition.

April 9: Launch of the Neutron Star Interior Composition Explorer (NICER) by SpaceX Falcon 9. This will be the first mission to re-use a Dragon capsule.

April 10: Shane Kimbrough, Sergey Ryzhikov and Andrey Borisenko return from the Space Station.

April 12: [tentative] Oklahoma Space Industry Development Authority [OSIDA] meets at 1:30 p.m. at the Oklahoma Department of Transportation Building in Oklahoma. Call 580-562-3500 to verify.

April 12: Yuri's Night. 56th anniversary of manned orbital space flight.

April 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.

April 14: Uranus is in conjunction with the Sun.

April 20: Mercury is in inferior conjunction with the Sun.

April 20: Expedition 51 members Jack Fischer, Fyodor Yurchikhin are launched to Space Station. Since only two astronauts are being launched, the Space Station crew will be down to five.

April 22: Peak of Lyrid meteor shower.

May 5: Peak of eta Aquarid Meteor shower.

May 10: [tentative] Oklahoma Space Industry Development Authority [OSIDA] meets at 1:30 p.m. at the Oklahoma Department of Transportation Building in Oklahoma. Call 580-562-3500 to verify.

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 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 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 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 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: 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.

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 https://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 (SoI), 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)

| | |
|---|---------------------------|
| Steve Swift, President & <i>Update</i> Editor | 496-3616 (H) |
| David Sheely, Vice President | 821-9077 (C) |
| Syd Henderson, Secretary & <i>Outreach</i> Editor | 321-4027 (H) 365-8983 (C) |
| Tim Scott, Treasurer | 740-7549 (H) |
| Claire McMurray, Communications | 329-4326 (H) 863-6173 (C) |

OSA E-mail Addresses and Web Site:

sswift42 at aol.com (Steve Swift)
 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, 1155 15th Street NW, Suite 500, Washington DC 20005 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 – March 2017

102 W. Linn #1, Norman, OK 73069

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