

## OUTREACH November 2015

### November Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, November 14, 2015 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.

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](mailto: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.

### Program

2:00 – 4:00 p.m.

- 1) Introductions
- 2) Space Fence (David Sheely)
- 3) What's Happening (Steve Swift)  
Current Space News, Pictures, Videos & Links  
Including:
  - a. Kennedy Space Center Changes
  - b. Thumb Sized Satellites
  - c. Cygnus Spacecraft Flight Plans
  - d. Masten Systems
  - e. Human Flight Status
  - f. Recent Launches to Orbit
  - g. SpaceX Events and Plans
- 4) Discuss Business
  - a. Review OSA Accounts
  - b. Summary of August Meeting
  - c. Nominations of 2016 Officers
  - d. OSA Christmas Party
- 5) OSA Charter
- 6) OSIDA Meeting Report
- 7) Chat

### Minutes of October 10 Meeting

Oklahoma Space Alliance met at Earl's Rib Palace in Moore on October 10. Attending were Steve, Karen and Brian Swift, Patrick Cox, Will Decker, Russ Davoren, Christopher Gutierrez, Richard Holtzschue, Cliff McMurray, Isvin Prieto, Vickey Richartz, Tim Scott, Rosemary Swift, Rachelle Thibodeau, Dennis Wigley and Syd Henderson. This was Patrick's first meeting.

October 10 was the last day of World Space Week. [Comment: World Space Week is October 4 -10 of each year, and is the largest space-related celebration of the year, involving 1503 events this year in more than 80 countries. *Sputnik 1* was launched on October 4, 1957 and the Outer Space Treaty was signed on October 10, 1967.] Our meeting was planned to be shortened so people could see *The Martian* afterward.

Steve delivered a President's address, which was published in last month's *Update*. For those who don't have internet access, I reproduce it here:

Fully recognizing that progress in space exploration and settlement must proceed on a step by step basis, I sometimes need to pause, looking past the detail, and envision where all this space activity may lead. The following thoughts were selected from a vision I expressed in 2012 in a paper titled *Dancing among the Stars*:

Whereas the first people moving into space must focus on immediate missions and the requirements of survival, their goals will eventually broaden. With the passing of centuries, their numbers will multiply through new births and migrations until their pursuits resonate with diversity. Their own goals will differ as from the summons of a single bell to the inspiration of a magnificent overture. They should all be encouraged. Space has room enough to grow, time enough to learn, challenges enough for any spirit and opportunities for all. They should all be welcome. Let them sing their songs of life and dance among the stars.

There are those who say, "I'm not interested in some ideal cosmic destiny that will take eons to accomplish. If I was out there in space or on a planet I would work and have a share in a mining company or maybe a transport company."

The destiny envisioned is not about some idealistic quest for a nebulous future; rather, it is about living and working, about people and families, about achievement and reward and about reaching out to new opportunities. Accomplishing this vision and destiny requires not years but centuries and, yes, perhaps even eons. People are even now orbiting the earth. In a few years, more permanent bases and habitats will exist. In a few centuries, civilizations in space, on moons and on planets will flourish. Colonies will migrate to deep space and other solar systems. While the wave front of human expansion proceeds at its own pace, amazing and thriving civilizations will grow in its wake; the songs of life will flourish; and the laughter of children will ring out on many worlds.

We went over a plan to bag a near-earth asteroid and mine it for water. A lot of near-earth asteroids are actually the former nuclei of comets and can potentially contain a lot of water. The idea is to extract the water using concentrated sunlight to cook the asteroid. The company proposing to do this is APIS (Asteroid Provided In-Situ Supplies).

Blue Origin announced that they will be launching from Complex 36 at Cape Canaveral. This is the same complex that the Mariner missions, *Pioneer 10*, *Surveyor 1*, and many other unmanned payloads were launched, although it's been unused for ten years.

We looked at landscape pictures viewed from the ISS, including Lake Amadeus in Australia, and a section of the Bahamas cut by channels. The latter was such high resolution that if you look really close, you can see an airplane flying over the Bahamas.

NASA has confirmed the existence of liquid, if very salty, water on the surface of Mars.

China launched their first Long March 6 rocket on September 19, carrying a payload of twenty satellites, [Comment: Long March 6, aka Chang Zheng 6, is one of China's series next-generation launch vehicles, along with Long Marches 5 and 7. It's actually beaten Long March 5 to launch. Of these, Long March 5 is the heavy launch vehicle, Long March 6 small to medium launch vehicle, and Long March 7 medium to heavy launch vehicle. Long March 7's first launch has been postponed to next year. Long March 5 will also probably have its first test launch in 2016 and will be the launch vehicle for the *Chang'e-5* lunar sample-return mission in 2017.]

We didn't do much business at the meeting, but we do have \$991 in the checking account and \$203 in cash.

## Notes on OSIDA Meeting

The Oklahoma Space Industry Development Authority met on November 10 at the Oklahoma Department of Transportation building in Oklahoma City. Board members in attendance were Jack Bonny, Bailey Siegfried, Don Wetakam, Hay Edwards and Robert Cox. Vice Chairman Cox presided in the absence of Mr. Cunningham. Rosemary Swift, Syd Henderson and Dave Sheely attended on behalf of Oklahoma Space Alliance. Three other people intended, including Ross Robinson and a reporter.

Governor Fallin has ordered all state agencies to develop plans for cutting nonessential spending by 10%. OSIDA has one of the smallest budgets of any state agency, with little spending they deem nonessential. Plans are due by December.

Spaceports in America are developing new infrastructure including a large hangar at Spaceport America.

The Air Force's joint use agreement operations remain stable at the Spaceport. It sounds like the Spaceport does well out of this agreement.

The December meeting of the OSIDA board has been cancelled. The next meeting will be January 13 at the Attorney General's building on the north side of NE 21<sup>st</sup>, opposite the Department of Transportation Building. Most meetings in 2016 will be in the Commission Room at Department of Transportation building at 1:30

p.m. on the second Wednesday of the month.

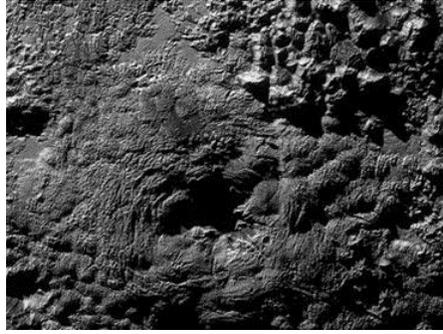


Figure 1 Wright Mons

## Space News: Pluto

Scientists will be going over the Pluto findings for years. *New Horizons* has revealed an interesting contrast between Charon's Organa and Skywalker craters, which are fairly near each other and look superficially similar (and are named, informally, after Princess Leia and Luke Skywalker from *Star Wars*). Skywalker crater is mostly just water ice, like most of the surface of Charon, but Organa crater is rich in frozen ammonia, which is something we haven't seen on Charon. Possibly the impact which created Organa released a subsurface reservoir of ammonia, or the impactor itself was rich in ammonia. Also, although ammonia is frozen on the surface of Pluto, it also lowers the melting point of ice to the point where cryovolcanoes may once have existed on Charon.

Cryovolcanoes certainly seem to exist on Pluto itself. Two volcanoes, informally named Wright Mons and Piccard Mons (after the Wright brothers and Piccard family) which are tens of miles across and several miles high have been discovered with large craters and apparent flows of material down the sides. It's not known whether they are still active, but parts of Pluto's surface are relatively young, and volcanic action would certainly help to explain why.



Figure 2 Pluto's Moons Nix and Hydra

*New Horizons* has also been sending pictures of Pluto's four small moons, which hold more surprises. First of all, Kerberos, which was supposed to be one of the biggest of the four and very dark, turns out to be about the same size as tiny Styx, and as shiny as the other moons. Also, although it might be expected that these small moons might have their rotations synched somehow with Pluto and Charon, in fact they rotate pretty rapidly, with Hydra in particular rotating 89 times per orbit, which translates to a rotational period of ten hours. (This period may vary, however, since Hydra rotates chaotically with no fixed axis.) Hydra and Kerberos each seem to have been formed by the merger of two moons. It's possible that Styx may as well, but it's hard to tell because our only pictures of Styx have such poor resolution.

In fact, the only one of Pluto's lesser moons of which we have good pictures is Nix, which appears to be a somewhat bland space rock—in fact so bland that it looks to me to have a rather young surface, though there are at least six craters on its surface, the largest about ten miles in diameter. Nix does have a 26 by 22 mile red-dish spot that needs explanation, especially on a moon which has a long axis of 33 miles.

## Other Space News

On December 7, Japan's *Akatsuki* spacecraft (formerly known as the Venus Climate Orbiter and Planet-C), will be making a second attempt to enter orbit around Venus. It first reached Venus on December 7, 2010, but failed to enter orbit, and has been in heliocentric orbit ever since. The probe performed several orbital corrections, the most recent in August, so we know its rockets are still functioning, but there were concerns that the spacecraft may have been damaged by its extended series of solar approaches and overheating.

A mysterious object dubbed WT1190F will enter the Earth's atmosphere on November 13. Since it appears to be hollow (from the way it interacts with solar radiation), it is assumed that it is a piece of spacecraft debris that has been recaptured by the Earth. The orbit is strange, with a perigee of 13,000 miles and apogee of 400,000 miles (and is clearly changing). The object is most likely a rocket booster or solar panel. It's conceivable that part of it may reach the Earth's surface, so it's fortunate that any surviving debris is expected to land in the Indian Ocean.

The *MAVEN* spacecraft has detected the process which may have depleted Mars's atmosphere. It does appear to have resulted from the solar wind, with increased loss of gas during solar storms. The amount lost per second is only about a quarter of a pound, but that adds up; it's equivalent to 4000 tons per year, and would have been higher when the Sun was younger and more inclined to solar storms.

## 100 Years of General Relativity

November 2015 is the 100<sup>th</sup> anniversary of Albert Einstein's presentation of his General Theory of Relativity to the Prussian Academy of Science, with publication that December. Einstein had in 1905 published his Special Theory of Relativity, which dealt with objects moving at a constant velocity and the consequences of the speed of light in a vacuum being constant in all directions to a moving observer. The General Theory of Relativity deals with objects under acceleration, and how objects act in a gravitational field. Unlike the Special Theory, which presents paradoxes, but actually has fairly easy equations, General Relativity is much more mathematically difficult, including tensors, and a geometry which bends in the presence of a gravitational field, and a gravitational equation that is opaque at first glance (and includes a term involving density).

The last might require a bit of an explanation. In Einstein's geometry, gravitational fields stretch distances in their vicinity, but the shape of the geometry is different if the mass is diffuse and widely distributed, or concentrated in a body with small diameter. The gravitational well in the first case is wider and shallower.

Consequences of General Relativity include gravitational lensing, black holes, the possibility of an expanding universe, time dilation in orbiting bodies, the red-shifting of light emanating from a gravity well, gravitational waves, and the existence of dark matter (and once it was realized the expansion of the Universe is accelerating, dark energy).

There are numerous articles celebrating Einstein's achievement this month, including full spreads in the October 10 *New Scientist*, December *Sky & Telescope*, and November *Astronomy*. And, although General Relativity passes every test thrown at it, so does quantum mechanics, and the two still have never been reconciled.

## Sky Viewing

If you could see the asteroids, what would the sky look like? Here's an amazing simulation by Scott Manley: <https://www.youtube.com/watch?v=huC3s9lsf4k&feature=youtu.be>.

The **Geminid** meteor shower peaks the nights of December 13 – 14. This year's shower peaks just after the new Moon, so it should be an excellent time for viewing. You may see a meteor per minute starting about 10:00 p.m., with about two meteors per minute in the morning.

The **Leonid** meteor shower peaks on November 17, but this is an off-year and it's not expected to be spectacular, with maybe fifteen meteors per hour. More interesting is the extended **Taurid** meteor shower, which has been producing fireballs, but that will be pretty much over by the time you get this newsletter.

Comet 2013 US10 (**Catalina**) will be fifth magnitude from late November through January, which is barely within naked-eye visibility in a very dark sky, but easily visible even with weak binoculars. At the moment, it is near the southern part of the boundary between Virgo and Libra, but will cross the legs of Virgo as it makes a beeline to Arcturus, which it will reach on New Year's Day. In mid-January, it will buzz the end of the handle of the Big Dipper.

**Mercury** is currently lost in the sunrise as it approaches superior conjunction with the Sun on November 17, and will not be visible for the rest of November or in early December. However, it will become visible after sunset in mid-December, and by December 28, when it reaches greatest elongation, it will be setting an hour and a half after the Sun.

**Venus, Jupiter** and **Mars** have been having a series of conjunctions in the morning sky, but that's done now. Still, **Venus** is magnitude -4.4 and Jupiter is magnitude -1.8, and Mars, between them, is only magnitude 1.7. The line joining them is stretching and by the end of the month, Mars will be twenty degrees below Jupiter and Venus fourteen degrees below Mars.

**Venus** will still be setting several hours after the Sun throughout December, but is gradually growing fainter as it moves away from us, but it doesn't reach superior conjunction until next June.

**Jupiter**, on the other hand, is rising earlier each night and gradually brightening. It's currently rising about 2:00 a.m., but by the end of the month, will be rising around 12:30 a.m., and by the end of December, will be rising around 10:30 p.m., at which point it will be magnitude -2.2.

**Mars** is rising about 2:30 a.m., and will rise at 2:00 a.m. in early December and 1:30 a.m. at the end of December. It's also very slowly getting brighter, but will only be magnitude 1.3 by December 31.

**Saturn** is currently low in the west at sunset and is probably not visible. Saturn is approaching conjunction with the Sun on November 30, and won't become visible again until mid-December, when it rises an hour before the Sun. By the end of December, Saturn will be rising two hours before the Sun, and, at magnitude 0.5, will be easily visible in the northern part of Scorpius six degrees above Antares.

**Uranus** is magnitude 5.7, still in Pisces, and pretty high in the southeast at sunset, and by the end of December will be due south at sunset. **Neptune** is magnitude 7.8, will still be in Aquarius for years, and is currently in the south at sunset, but by the end of December will be in the southwest at sunset.

[Material for this section of *Outreach* derives from the November and December issues of *Astronomy* and *Sky & Telescope*, and the *Sky & Telescope* web site.]

## Viewing Opportunities for Satellites (November 14 to December 14, 2015)

You can get sighting information at [www.heavens-above.com](http://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, so I'm using Heavens Above for that. The *Sky & Telescope* web site carries International Space Station observation times for the next few nights at [skyandtelescope.com/observing/almanac](http://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.

Missions to and from the International Space Station may change its orbit. The Progress 62P Cargo Craft launches to the ISS on November 21 and an Orbital Sciences Cygnus launches on December 3. The next manned launch, however, isn't until December 15. Note, though that Expedition 44 will be returning on September 11.

#### HST November 13, 2015

Time	Position	Elevation
7:03 p.m.	224°	20°
7:04	205	27
7:05	177	31
7:06	151	27

Vanishes into Earth's shadow

#### HST November 14, 2015

Time	Position	Elevation
6:54 p.m.	226°	20°
6:55	208	27
6:56	180	31
6:57	153	27
6:57:17	146	25

Vanishes into Earth's shadow

#### Tiangong 1 November 15, 2015

Time	Position	Elevation
Appears from Earth's shadow		
6:14 a.m.	249°	13°
6:17	335	73
6:20	60	10

#### HST November 15, 2015

Time	Position	Elevation
6:45 p.m.	229°	20°
6:46	210	28
6:47	178	30
6:48	153	27
6:49	138	20

#### ISS November 22, 2015

Time	Position	Elevation
6:28 a.m.	332°	18°
6:29	356	29
6:30	37	37
6:31	78	28
6:32	98	18

#### ISS November 24, 2015

Time	Position	Elevation
6:18 a.m.	309°	21°
6:19	306	41
6:20	233	82
6:21	140	42
6:22	137	21

#### Tiangong 1 November 25, 2015

Time	Position	Elevation
Appears from Earth's shadow		
6:29 a.m.	302°	14°
6:32	24	70
6:35	110	10

#### Tiangong 1 November 27, 2015

Time	Position	Elevation
Appears from Earth's shadow		
5:55 a.m.	283°	54°
5:56	208	80
5:59	60	10

#### ISS December 4, 2015

Time	Position	Elevation
6:49 p.m.	242°	21°
6:50	254	39
6:51	319	63
6:51:28	8	5.3

Vanishes into Earth's shadow

#### ISS December 5, 2015

Time	Position	Elevation
5:55 p.m.	207°	20°
5:56	192	37
5:57	135	55
5:58	87	36
5:59	62	20

5:47	17	36
5:48	32	20

## ISS December 6, 2015

Time	Position	Elevation
6:38 p.m.	275°	15°
6:39	294	23c
6:40	326	27
6:41	351	23
6:42	17	15

## Tiangong 1 December 9, 2015

Time	Position	Elevation
6:34 p.m.	243°	10°
6:37	331	87
6:40	59	52
Vanishes into Earth's shadow		

## ISS December 7, 2015

Time	Position	Elevation
5:44 p.m.	249°	21°
5:45	265	37
5:46	321	54

## Tiangong 1 December 11, 2015

Time	Position	Elevation
5:59 p.m.	254°	10°
6:02	336	62
6:04	60	14
Vanishes into Earth's shadow		

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 at 5:57 p.m. on December 5, measure four-and-a-half fist widths south from east (in other words, look due southeast), then five-and-a-half 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: Not much this month since we are between crew launches and SpaceX launches. The next crew launch is December 15.

December 3: 3:30 p.m.: Coverage of Orbital Sciences Cygnus launch to the Space Station. Actual launch is at 4:55 p.m.

December 6: 3:30 a.m. Coverage of rendezvous and grapple of the Cygnus cargo craft to the Space Station, Actual grapple is 5:05 a.m.

### Calendar of Events

November: Venus, Mars and Jupiter will be close together in the sky, with a couple of conjunctions.

November 14: Oklahoma Space Alliance meeting, Harry Bear's All-American Grill

November 17: Mercury is in superior conjunction with the Sun.

November 17: Peak of Leonid meteor shower.

November 21: Progress 62P Cargo Craft mission to the Space Station launches from Baikonur, Kazakhstan.

November 29: Saturn is in conjunction with the Sun.

December 3: Fourth Orbital Sciences Commercial Resupply Mission to the Space Station launches around 5:00 p.m. from Cape Canaveral. This marks the resumption of Orbital Services Cygnus flights after the failed launch on October 28, 2014.

December 7: Japan's *Akatsuki* space probe goes into orbit around Venus. [This is the second attempt to achieve orbit, the first failing in December 2010.

December 12: [Tentative] Oklahoma Space Alliance Christmas Party, location to be announced.

December 14: Peak of Geminid meteor shower.

December 15: Launch of Expedition 46 to the Space Station.

December 22: Peak of Ursid meteor shower.

December 28: Mercury is at greatest elongation, 20 degrees east of the Sun (so can be seen after sunset).

Early 2016: Launch of *ASTRO-H* (or NeXT), the Japanese X-ray astronomy satellite.

Sometime in 2016: Launch of the Chinese space station *Tiangong-2*.

Sometime in 2016: First launch from Russia's Vostochny Cosmodrome in eastern Siberia, in Amur Oblast which is north of the northern tip of Manchuria.

Sometime in 2016: 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.

January 3, 2016: SpaceX launches CRX 8, a cargo supply mission to the Space Station. This marks the resumption of such flights after the explosion of CRX 7 on June 28, 2015. The Bigelow Expandable Activity Module will be delivered by this flight. [Postponed from November.]

March 2016: Launch of Expedition 47 to the Space Station.

March 21, 2016: Launch of SpaceX's Dragon capsule on a resupply mission to the Space Station.

April 12, 2016: Yuri's Night.

March 8 – 17, 2016: Proposed launch date for *InSight*, a lander that will probe the interior of Mars. For information, see <http://insight.jpl.nasa.gov/>. This launch also includes Mars Cube One, a communications CubeSat that will be the first Cubesat to operate beyond Earth orbit.

March 10: Fifth Orbital Sciences Commercial Resupply Mission to the Space Station launches from Cape Canaveral.

May 9, 2016: Mercury transits the Sun's disk. Oklahoma sees most of the transit, but it is visible in its entirety in the eastern US, western Europe and all of South America.

July 4, 2016: *Juno* arrives at Jupiter. The NASA *Juno* page is [http://www.nasa.gov/mission\\_pages/juno](http://www.nasa.gov/mission_pages/juno).

July 2016-2020: The *New Horizons* probe visits the Kuiper Belt.

July 20, 2016: Moon Day: anniversary of the Apollo 11 landing on the Moon.

September 2016: Launch of *OSIRIS-REx*, the Origins Spectral Interpretation Resource Identification Security Regolith Explorer, which will orbit the near-earth asteroid 101955 Bennu and return samples. For more information, visit <http://en.wikipedia.org/wiki/OSIRIS-REx> or <http://science.nasa.gov/missions/osiris-rex/>.

October 4 – 10, 2016. World Space Week. See <http://www.worldspaceweek.org> for details.

December, 2016: ESA's *ExoMars Mars Orbiter* arrives at Mars, together with the Schiaparelli lander. (The rover will be launched in 2018.) For more information, visit [en.wikipedia.org/wiki/Exomars](http://en.wikipedia.org/wiki/Exomars).

Sometime in 2017: 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>.

Sometime in 2017 [tentative]: China launches the *Chang'e 5* lunar sample return mission.

Sometime in 2017: India launches *Chandrayaan 2*. This mission will include a lunar rover. For more information, visit <http://en.wikipedia.org/wiki/Chandrayaan-2>. [Moved from 2014.]

January 12, 2017: Venus is at greatest eastern elongation, 47 degrees from the Sun (so can be seen after sunset).

January 27, 2017: The European Space Agency/JAXA *BepiColombo* Mercury Orbiter is launched. Home page is <http://sci.esa.int/bepicolombo>. [Moved from July 2016.]

February 2017: Launch date for the proposed Fast Infrared Exoplanet Spectroscopy Survey Explorer (FINESSE), which will study the atmospheres of hundreds of exoplanets.

June 3, 2017: Venus is at greatest western elongation, 46 degrees from the Sun (so can be seen before sunrise).

August 2017: Proposed launch of TESS, the Transiting Exoplanet Survey Satellite. Unlike *Kepler*, TESS will (if approved) conduct a full sky search for exoplanets.

August 21, 2017: 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.

Sometime in 2018: Russia launches the lander of the “Luna-Glob” mission, which will deploy 13 mini-probes upon the lunar surface. For more information, see <http://en.wikipedia.org/wiki/Luna-Glob>.  
Sometime in 2018 or 2019: Russia launches the orbiter of the “Luna-Glob” mission. [These missions keep getting delayed, and expect more delays.]

May 2018: ESA launches the *ExoMars Mars Rover*. For more information, visit [en.wikipedia.org/wiki/Exomars](http://en.wikipedia.org/wiki/Exomars).

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](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.)

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

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](http://sci.esa.int/solarorbiter). [Moved from July 2017.]

Sometime in 2019 or 20: Russia launches the “Luna-Resurs mission, which will deploy 13 mini-probes upon the lunar surface. For more information, see <http://en.wikipedia.org/wiki/Luna-Glob>.

January 2019: ESA’s *ExoMars Mars Rover* arrives at Mars. For more information, visit [en.wikipedia.org/wiki/Exomars](http://en.wikipedia.org/wiki/Exomars).

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.

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

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>.

January 2022: *BepiColombo* arrives at Mercury orbit.

Sometime in 2023: Arrival of OSIRIS-Rex at the near-earth asteroid 101955 Benu to return samples. [See September 2016.]

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

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, 2015 (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:**

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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](mailto: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](http://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](http://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](http://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](http://www.marsociety.org).

The National Space Society's Headquarters phone is 202-429-1600. Executive Director e-mail [nsshq@nss.org](mailto:nsshq@nss.org). The Chapters Coordinator is Bennett Rutledge 720-641-7987, [rutledges@chapters.nss.org](mailto: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](http://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](http://www.planetary.org). E-mail is [tps@planetary.org](mailto:tps@planetary.org).

NASA Spacelink BBS 205-895-0028. Or try [www.nasa.gov](http://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 (\$35 for new international members). Regular membership rates are \$55, international \$65. Student memberships are \$18 new, \$25 renew. Senior memberships are \$20 new, renew \$40. Part of the cost is for the magazine, *Ad Astra*. Mail to: National Space Society, 1155 15th Street NW, Suite 500, Washington, DC 20005, or join at [www.nss.org/membership](http://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](http://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, Box 273, Indian Hills CO 80454.

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OSA Memberships are for 1 year, and include a subscription to our monthly newsletters, *Outreach* and *Update*. Send check & form to **Oklahoma Space Alliance, 102 W. Linn, #1, Norman, OK 73071**