

Oklahoma Space Alliance OUTREACH

September 2016

September Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, September 10, 2016 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.

We were hoping that Congressman Bridenstine would speak at this meeting, but it now looks like that make take place in September or October. OSA president Steve Swift is undergoing medical treatment and won't be able to preside, so OSA VP Dave Sheely will lead the meeting.

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

- 1) Introductions
 - a. Space News, Pictures, and Videos by David Sheely
- 2) Break
- 3) Elon Muck on 60 Minutes <https://www.youtube.com/watch?v=YmGMLdZY1HA>
- 4) Discuss Business
 - a. Review OSA Accounts
 - b. Summary of August Meeting
 - c. Visit by Congressman Bridenstine delayed until November, per Steve Swift
 - d. Meeting with Steve Carson from Senator Lankford's office
 - e. Enterprise in Space
 - f. Initiating a Lunar Power Utility, L5 Sacramento
 - g. Changes to the Chapter's Assembly bylaws
- 5) Chat

Minutes of August Meeting

Oklahoma Space Alliance met at Earl's Rib Palace in Moore on August 13, 2016. In attendance were Dave Sheely, Syd Henderson, Bryan Swift, Karen Swift, Rosemary Swift, and Claire and Clifford McMurray. And Tracee (no last name given). OSA President Steve Swift is still undergoing medical treatment, so in his absence, Vice President Dave Sheely presided.

We have \$1045.99 in the bank account and \$257 in cash, for a total of \$1302.99.

We watched a video of the July 18 SpaceX resupply mission to the Space Station. This mission also had a successful first-stage landing at Cape Canaveral.

Dave Sheely is going to meet with Senator Langford. He's currently talking to the Senator's aides.

On August 3, the Moon Express received permission from the FAA to launch a rocket that will go to the Moon in 2017. [This, by the way, gives the Moon Express a great chance to win the Lunar X-Prize, although Astrobotic plans to launch via SpaceX by the end of the year. First prize is \$20 million. Second

prize is \$5 million. For more information, see <http://www.space.com/30720-moon-express-private-lunar-launch-2017.html>]

There was an article on the Oklahoma Spaceport in the *Oklahoman*.

The Humans to Mars Summit was May 17 – 19 at George Washington University and videos are available.

China had a surprise launch of a Long March 3 rocket apparently with a classified payload.

We watched a promotional video for *Dreamcatcher* by the Sierra Nevada Corporation.

The World Space Week is around October 4. [Exact dates are October 4 – 10. We have an OSA meeting on October 8.] We can try a field trip during that time to the Remote Sensing Lab at OU.

If we can arrange a meeting with Representative Bridenstine, we could have it at a library.

We watched a Robert Zubrin video in which he was making his Case for Mars at a Moscow conference. The Saturn V could take 140 tons to LEO, which was enough to build a Mars Direct mission. If you took smoking tobacco from an astronaut and sent him to Mars, he would suffer a lower risk of cancer than if he were to stay on Earth and continue smoking.

The surface area of the Moon is approximately equal to that of North and South America put together. [It's 42.5 million square kilometers for the Americas to 37.7 million for the Moon, but the estimate may not be including Greenland and other islands.]

There may be more platinum on the surface of the Moon than all the reserves on Earth.

We watched Moonshot episode 6 about the Moon Express.

OSIDA notes: The OSIDA board met on August 10. Dave Sheely went on the behalf of OSA.

THOR GUARD lightning prevention and detection equipment was received at the Spaceport.

There is now a National Association of Spaceports to which OSA is a member.

--Minutes by OSA Secretary Syd Henderson

Space News: Falcon 9 Explosion

A SpaceX Falcon 9 rocket exploded on the launch pad on September 1, destroying an Amos-6 communications satellite built by Israel Aerospace Industries for Spacecom. The satellite cost \$195 dollars, and Facebook had signed a \$95 million dollar contract to lease broadband capability, part of which was to service sub-Saharan Africa.

There's some dispute over what caused the explosion, which occurred during a test fire prior to launch. (SpaceX usually has the satellite on board when they do this routine test.) SpaceX claims a pad anomaly rather than a problem with the rocket itself. The explosion started near the second-stage liquid oxygen tank, which may indicate that it was a pad anomaly since it was the first-stage engines that were being rested.

The cost of the satellite is actually covered by the insurance of Israeli Aerospace Industries, which will compensate Spacecom. If the explosion had occurred during flight, Spacecom's own insurance would have covered. Spacecom gets to choose whether to get a \$50 million compensation from SpaceX or a free future flight.

Whatever the cause, this puts a crimp in SpaceX flights for the near future, which include satellite launches, Space Station resupply missions (the next one's in November), and unmanned capsule to attach to the Space Station in May 2017, and a manned flight to the Space Station in December 2017.

The regions of Africa that would have been covered by Amos-6 include South Africa, all the nations on the coast of Africa from Senegal to northern Angola (except for the central part of the

Democratic Republic of Congo), Kenya, Ethiopia, Uganda, Rwanda and Burundi. For some reason, the Central African Republic, Namibia, Zambia, Zimbabwe, Botswana and most of Mozambique would not have been covered.

[Sources are Facebook and space.com]

Space News: Proxima Centauri Has a Planet!

The big astronomical news this month is the probable discovery of an Earth-sized planet in the habitable zone of Proxima Centauri, the nearest star to the Sun.

Proxima is a probably a member of the Alpha Centauri triple star system, and is 4.25 light-years away, while Alpha Centauri A and B are 4.37 light-years away. Proxima is 1.4 trillion miles from Alpha Centauri, which is why there is some possibility that it isn't actually bound to Alpha Centauri. If it is, it would have an orbital period on the order of 500,000 years, and could be referred to as Alpha Centauri C. [Incidentally, the Alpha Centauri triple-star system is the home systems of the Trisolarians in Cixin Liu's excellent *The Three-Body Problem*, although Proxima in that seems larger and closer to the other two stars for dramatic purposes.]

Despite its closeness, Proxima Centauri is only magnitude 11, which is far too dim to be seen by the naked eye. It's dimmer than all the planets and at least fifty asteroids. Proxima has a diameter a seventh that of the Sun, or, to put it another way, it is only 1.4 the diameter of the Jupiter. Its mass is one-eighth that of the Sun, which means it's also about 40 times as dense because it's much cooler and less internal radiation pressure. Proxima is a red dwarf with a surface temperature of 5500° F compared to about 10,000° F for the Sun.

Since Proxima is so cool and dim, a planet must be close to it to be its habitable zone, and, indeed, Proxima b is only five million miles from its star and has a year that lasts 11.2 days. This puts it well within its Proxima's habitable zone. Since minimum estimates are that Proxima b has only 1.3 times the mass of the Sun, stories have been describing it as "Earth-like." However, the diameter of the planet is unknown since it does not cross Proxima's disk and we're still a way from being able to directly observe it. The planet could also have several times that minimum mass if its orbit is tilted to our line of sight.

As far as habitability goes, Proxima b would have some problems. First of all, a planet that close to a star probably has its rotational period locked to the star, with one face always facing the star. This means the side of the planet facing Proxima would be hot and the far side very cold, with liquid water only possible closer to the terminator. However, other tidal locks are possible, such as Mercury, which rotates three times per two orbits. If Proxima b does that, then it would merely have a day equivalent to a week on Earth, which might be good enough for life.

But life would face another big obstacle, because Proxima Centauri, like many red dwarfs, is a flare star, and periodically gives off large amounts of charged particles. If Proxima b doesn't have a strong magnetic field, it may have lost its atmosphere. On the other hand, if it does have a magnetic field (and given its mass, it well may), it may simply have really spectacular auroras. Proxima b also gets about a hundred times as many X-rays from its star as does the Earth.

It's worth noting that we will soon know a lot more about Proxima b. The VLT Survey Telescope or VLS* in Chile's Atacama Desert is about to add the ESPRESSO spectrograph which should be able to detect spectral lines from the planet. In addition, since Proxima Centauri is so close, it should be possible to see it directly see it with telescopes now being built, including the James Webb Space Telescope.

Proxima b may not be an only planet. However, the signals of other planets are difficult to detect since Proxima is itself such an active star.

The fact that the closest star to the Sun has a planet not much larger than the Earth is yet another indication that such planets must be very common in the Milky Way.

What are the chances we might send a probe to Proxima Centauri in the near future? If Breakthrough Starshot comes to pass, very likely. This is the project being funded by Yuri Miler and supported by Stephen Hawking. This tiny satellite could launch as early as 2038 (if Milner gets a lot

more funding) and could reach Proxima in thirty years. When I say tiny, I mean a centimeter wide probe, and it will require a gigawatt laser to bring it up to speed.

*Since VLT means Very Large Telescope, this is the Very Large Telescope Survey Telescope.

Other Space News

The *Juno* spacecraft is now in orbit around Jupiter, and on August 27 completed the first of its flybys since it achieved orbit. Since its instruments were turned off during its initial flyby, this is the first time it's gotten to take closeups of Jupiter. During this encounter, *Juno* passed over both poles of Jupiter, and in between approached within 2500 miles of the top of Jupiters clouds. This was the first of 36 scheduled encounters.

Figure 1 Aurora Australis of Jupiter as seen by Juno (NASA)



Figure 1: North Pole of Jupiter as seen from Juno Spacecraft (NASA Photo)

First view of Jupiter's north pole (see cover) shows a lot of storms and no sign of bands at all. There is no sign of a hexagon such as that which adorns the north pole of Saturn. The clouds are a lot bluer than expected. There is also an X-ray aurora of sorts at the North Pole that has persisted for at least ten years. The south polar region of Jupiter was adorned itself by a brilliant aurora (the image above is from an infrared camera).

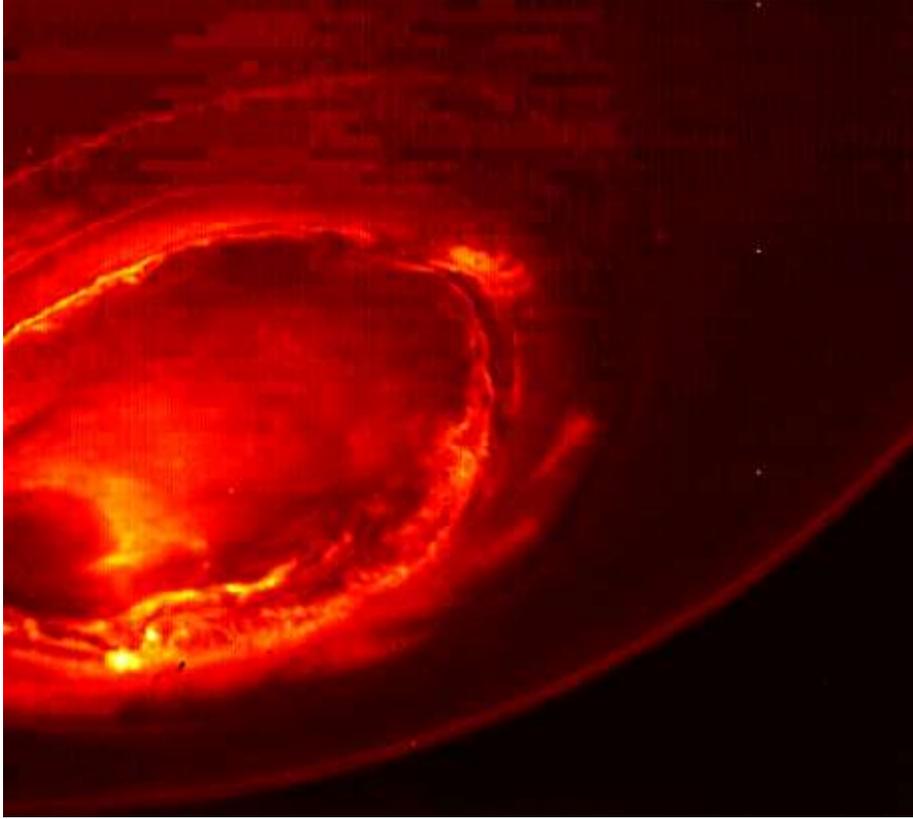


Figure 3:: Aurora Australis (Infrared false color) of Jupiter as seen from Juno Spacecraft (NASA Photo)

As I write this, NASA is preparing for the September 8 launch of *OSIRIS-REx*, which will be its first sample-return mission to an asteroid. This is a seven-year mission, starting with two-years traveling to the half-kilometer wide near-Earth asteroid Bennu, where it will spend two years investigating the asteroid. In July 2020, *OSIRIS-Rex* will briefly touch down on the surface of Bennu, collecting material for its return mission. In March 2021, it will leave Bennu and travel two-and-a-half years back to Earth. The launch of *OSIRIS-Rex* will not be affected by the explosion of the SpaceX rocket on a nearby launch pad.

The Philae lander has at last been located on the surface of Comet 67P/Churyumov-Gerasimenko. When it landed, it bounced a couple of times and landed in a crevice and on its side. *Rosetta* was able to find it because it was less than two miles above the surface of the comet as it prepares for its September 30 landing. [For an article, see <http://www.skyandtelescope.com/astronomy-news/esa-locates-philae-lander>]

KIC 8462852, mercifully nicknamed Tabby's Star, continues to defy explanations. This is the star about which there was a lot of fuss a year ago because of its unusual light fluctuations which some postulated to be due to an alien megastructure. Its nickname refers to Tabetha S. Boyajian, who was the lead author of the article reporting the star's weird behavior.

Tabby's Star itself seems to be a normal third (absolute) magnitude star, except that it undergoes irregular drops in brightness of up to twenty percent for days at a time. This immediately eliminated transits planets as a cause, since the drops would be regular, and Tabby's Star is too old for dust clouds or youthful pulsations. So the best explanation Boyajian's team could come up with was swarms of comets blocking the light with their tails. However, this was an explanation of which even the team seemed skeptical. More exotic explanations included a Dyson Sphere under construction.

The comet swarm theory seems to be disposed of, because Tabby's Star appears to have been gradually growing dimmer by up to a century, and even more rapidly in recent data from the Kepler Telescope. This leaves astronomers without a good explanation of the star's behavior. Well, the Dyson sphere hypothesis is still alive, I guess, but there are no unusual signals from that part of space. My hypothesis is that there's an invisible nebula between us and the star, a hypothesis that could be tested if there are other stars in the vicinity of Tabby's Star showing similar fluctuations. However, Tabby's Star is in the region that was intensively studied by Kepler so you'd think such fluctuations would already have been detected.

Speaking of aliens, there was a brief flurry of excitement about a possible alien signal from the star HD 164595 detected on May 15, 2015 by the Russian RATAN 600 radio telescope. The signal was strong in the 11 gigahertz band. However, SETI scientists pointed out that they get about 72 events per day of a similar quality, and most turn out to be interference. And subsequently, no repeats of the signal were found, either by the RATAN 600 team, the SETI Institute, or Breakthrough Listen (or anyone else).

One of the reasons this event got so much public attention is that HD 164595 also has one known planet. However this planet has 13 times the mass of Earth and orbits its star in 40 days. Since HD 164595 is almost identical to the Sun, its planet must be considerably hotter than Mercury. There may be other planets, but with only one telescope receiving one signal, it most likely was interference from Earth.

Astronomy.com has a good article on the signal and the whole business of looking for possible alien signals at <http://www.astronomy.com/news/2016/08/the-promising-seti-signal-probably-isnt-aliens>.

Sky Viewing

There was an annular eclipse of the Sun that crossed central Africa on September 1. Next eclipse is another annular one in February 2017 which crosses the southern tip of South America, the South Atlantic, and central Angola. The next one after that, however, on August 21, 2017, is not only total, but crosses the United States from the Washington/Oregon boundary to South Carolina. That one will also be partial across all of North America.

If you've been watching the southern sky in the evenings, you may have noticed that **Mars** and **Saturn** have been having a dance with the first-magnitude star Antares, at this writing forming an equilateral triangle, which will be spoiled by the weekend as Mars separates from the other two. Of the three, Mars is the brightest at magnitude -0.2, with Saturn at magnitude 0.5 and Antares at magnitude 1.0. Saturn is the one highest in the sky. At the moment, Mars and Saturn are actually in the constellation Ophiuchus, which actually contains more of the ecliptic than Scorpius. Mars will move across the bottom edge of Ophiuchus until September 22, when it enters Sagittarius.

Saturn, meanwhile, will stay in the southwestern corner of Ophiuchus, where it will meet **Venus** in late October. In fact, on October 27, Venus will pass midway between Saturn and Antares.

Jupiter and **Venus** had a pretty spectacular conjunction on August 27, marred by them both being very low in the western sky. They're heading in different directions, with Jupiter heading toward a September 26 conjunction with the Sun, while Venus is gradually separating itself from the Sun and will dominate the evening sky during late fall and all of winter. Greatest elongation is in January, with inferior conjunction in late March. Venus is at maximum brightness midway between greatest elongation and inferior conjunction, which means it will be brighter each month each night for the next six months.

Jupiter won't be visible again until mid-October, when it will be rising before the Sun.

There was a third planet hanging around Venus and Jupiter, namely **Mercury**, which is heading toward a September 12 inferior conjunction with the Sun. However, it moves so rapidly across the sky, that in late September, it has its best appearance of the year, appearing eight degrees above the eastern horizon a half-hour before sunrise on September 22, and reaching greatest elongation on September 28, at which time it will be magnitude -.5 and eleven degrees above the horizon. On September 29, the (thin) crescent Moon passes within a degree of Mercury.

Unlike, Venus, Mercury is brightest between greatest elongation and superior conjunction, so it actually brighter in October, peaking at magnitude -1.1 on October 11 (and, incidentally 0.8 degrees to the left of the reappearing Jupiter, which is itself magnitude -1.7). However, they are only five degrees above the horizon a half-hour after sunset. Mercury is in superior conjunction with the Sun on October 27.

September is the best month of the year for viewing **Neptune**, which was at opposition on September 2. Unfortunately, it is magnitude 7.8 (as always—brightness doesn't change that much for such a distant planet) and not visible to the naked eye, but it can be seen in binoculars.

For **Uranus**, October is the month, since it comes to opposition on October 15. Uranus is magnitude 5.7 (again, as always) and is theoretically visible to the naked eye in very dark skies. Neptune's in Aquarius, and Uranus in the neighboring constellation Pisces.

Sky & Telescope has finder charts for Uranus and Neptune at www.skyandtelescope.com/wp-content/uploads/WEB_UrNep16_Finders.pdf. There are also finder charts on page 50 of the October 2016 issue of *Sky & Telescope* magazine. One advantage of searching for Uranus and Neptune is that once you've found them, they're pretty much in the same spot for many days afterward.

The asteroid Pallas is ninth magnitude and is passing this month through the constellation Equuleus, passing close to Alpha Equulei on September 11. This is notable as being the most interesting thing that has happened in Equuleus in years; it's a small constellation, has only two stars that are really visible in a dark sky, has no deep space objects of interest, and in my opinion, hangs around its big brother Pegasus hoping someone will notice it. Indeed, it's the second smallest constellation after Crux, which is actually conspicuous.

Oddly, Equuleus is not that hard to locate in a dark sky, because it is also next to Delphinus (the dolphin), which isn't that brilliant but has a distinctive tadpole shape.

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Viewing Opportunities for Satellites (September 9 to October 10, 2016)

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, 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.

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. There is an Orbital ATK Cygnus resupply mission to the Station launching in mid-September, and the September 23 launch of Expedition 49.

This is a poor month for viewing these satellites, with only one good evening viewing opportunity among them. Indeed, the Hubble Space Telescope has none at all since it is in Earth Shadow every time it's at its peak.

Station September 22, 2016		
Time	Position	Elevation
6:36 a.m.	311°	22°
6:37	311	43
6:38	144	87
6:39	134	41
6:40	134	22

Tiangong-1 September 22, 2016		
Time	Position	Elevation
Appears from Earth's Shadow		
6:24:43 a.m.	249°	20°
6:27	333	78
6:30	61	10

Station September 23, 2016		
Time	Position	Elevation
Appears from Earth's Shadow		
5:45 a.m.	352°	32°
5:46	39	43
5:47	84	32
5:48	103	19

Station September 29, 2016		
Time	Position	Elevation
8:21 a.m.	243°	21°
8:22	256	38
8:23	319	62
8:24	23	39
8:25	36	21

Tiangong-1 October 2, 2016		
Time	Position	Elevation
6:51 a.m.	298°	10°
6:54	27	83
6:57	115	10

Tiangong-1 October 4, 2016		
Time	Position	Elevation
Appears from Earth's Shadow		
6:19:11 a.m.	276°	36°
6:20:10	210	62
6:23	128	10

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 Tiangong-1 Space Station appear at 6:24:43 a.m. on September 22, you would measure two fist-widths south of due west, then two fist-widths above the horizon.

All times are rounded off to the nearest minute except for times when the satellite enters or leaves the shadow of the Earth. The highest elevation shown for each viewing opportunity is the actual maximum elevation for that appearance.

Programming Notice: NASA TV on the Web

Watch NASA TV (Public, Media and Education Channels) on your computer using Flash, Windows or QuickTime at <http://www.nasa.gov/multimedia/nasatv/index.html>.

NASA TV Schedules are available at <http://www.nasa.gov/multimedia/nasatv/schedule.html>

Highlights:

September 8, 2:30 p.m. Prelaunch coverage of *OSIRIS-REx*. [As near as I can tell, NASA-TV isn't covering the launch itself.]

September 23, 12:00 noon: Launch coverage of ISS Expedition 49-50 from Baikonur. (Actual launch is at 1:16 p.m.)

September 25, 1:30 p.m.: Coverage of docking of ISS Expedition 49-50 to the Space Station. (Actual docking is 2:33 p.m.) 4:00 p.m.: Coverage of hatch opening. (Actual opening is 4:30 p.m.)

Calendar of Events

September 8: 6:05 CST. Launch of *OSIRIS-REx*, the Origins Spectral Interpretation Resource Identification Security Regolith Explorer, which will orbit the near-earth asteroid 101955 Benu and

return samples. For more information, visit <http://en.wikipedia.org/wiki/OSIRIS-REx> or <http://science.nasa.gov/missions/osiris-rex/>.

September 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.

September 10: Oklahoma Space Alliance Meeting, 2:00 p.m. at Earl's Rib Crib in Moore, Oklahoma.

September 12: Mercury is at inferior conjunction with the Sun.

Mid-September: Launch of an Orbital ATK Resupply Mission to the Space Station.

September 23, 1:17 p.m.: Launch of Expedition 49 to the Space Station from the Baikonur Cosmodrome in Kazakhstan.

September 24 – October 2: Okie-Tex Star Party, Camp Billy Joe (36° 54' N, 102° 57' W; this put it near the northwest corner of the Oklahoma panhandle near Black Mesa.) See <http://www.okcastroclub.com/> for details.

September 26: Jupiter is in conjunction with the Sun.

September 28: Mercury is at greatest elongation, 20 degrees west of the Sun (so can be seen before sunrise).

September 30: The *Rosetta* space probe ends its mission with a descent to the surface of Comet 67P/Churyumov-Gerasimenko,

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

October 4: Seventh Orbital Sciences Commercial Resupply Mission to the Space Station launches from Cape Canaveral.

October 7: 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.

October 8: [Tentative]: Oklahoma Space Alliance Meeting, location to be announced.

October 15: Uranus is at opposition.

October 27: Mercury is at superior conjunction with the Sun.

November 4, 4:40 p.m.: Launch of the GOES-R environmental satellite from Cape Canaveral.

November 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.

November 12: [Tentative]: Oklahoma Space Alliance Meeting, location to be announced.

November 15: Launch of Expedition 50/51 crew to the International Space Station.

November 21: SpaceX launch to the ISS.

December: 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.

December: Test flight of SpaceX's Falcon Heavy.

December 10: Mercury is at greatest elongation, 21 degrees east of the Sun (so can be seen after sunset).

December 10: Saturn is in conjunction with the Sun.

December 10: [Tentative]: Oklahoma Space Alliance Christmas Party, location to be announced.

December 14: Peak of Geminid meteor shower.

December 19: Launch of SpaceX's Dragon capsule on a resupply mission to the Space Station.

December 28: Mercury is in inferior conjunction with the Sun.

December 30: Antares launch to the ISS.

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).

February 26, 2017: Annular solar eclipse touching the southern tip of South America, the south Atlantic Ocean, and Angola.

March 2017: Launch of the Green Propellant Infusion Mission (GPIM) by a SpaceX Falcon Heavy rocket. This mission is “green” because the fuel it uses, hydroxylammonium nitrate produces nontoxic gases when it burns, unlike hydrazine.

March 11, 2017: Launch of Expedition 51/52 to the Space Station.

March 25, 2017: Venus is in inferior conjunction with the Sun.

May 12, 2017: First demo flight of SpaceX’s Dragon 2 Spacecraft, 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.) Possibly may be postponed after the launch pad explosion earlier next month.

May 29, 2017: Launch of Expedition 52/53 to the Space Station.

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

August, 2017: First crewed demo flight of SpaceX’s Dragon 2 Spacecraft.

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.

September 15, 2017: The *Cassini* spacecraft will end its mission with a plunge into Saturn’s atmosphere.

September 30, 2017: Launch of Expedition 53/54 to the Space Station.

November 2017: Launch of Expedition 54/55 to the Space Station.

December 2017: 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.

December 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>.

December 2017: 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.

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

Sometime in 2018: Possible unmanned SpaceX mission to Mars.

February 2018: Crewed orbital test flight of Boeing’s CST-100 Starliner to the ISS. See https://en.wikipedia.org/wiki/CST-100_Starliner for details. April 2018: The European Space Agency/JAXA *BepiColombo* Mercury Orbiter is launched. [Postponed from January 2017.] Home page is <http://sci.esa.int/bepicolombo>.

May 2018: ESA launches the *ExoMars Mars Rover*. For more information, visit 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 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. [Moved from July 2017.]

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

September 2019: Arrival of OSIRIS-Rex at the near-earth asteroid 101955 Bennu to return samples. [See September 6, 2016.]

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*.

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.

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, 2016 (Area Code 405)

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David Sheely, Vice President	821-9077 (C)
Syd Henderson, Secretary & <i>Outreach</i> Editor	321-4027 (H) 365-8983 (C)
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sydh at ou.edu (Syd Henderson)

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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, rutledg-

es@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.

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