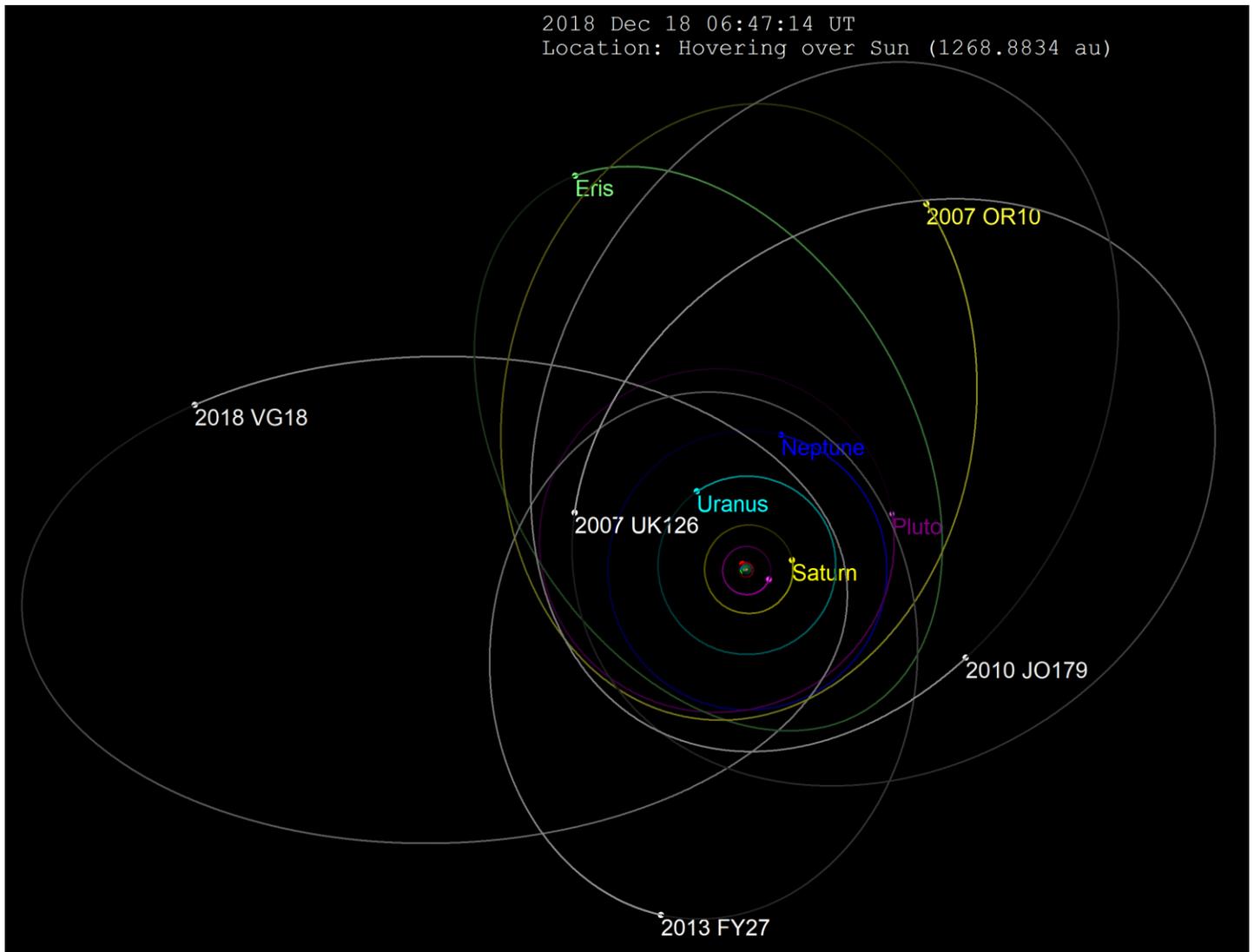


OKLAHOMA SPACE ALLIANCE

OUTREACH – March 2019

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet
At Tom and Heidi Koszoru's house
514 Fenwick Court in Norman
2:00 p.m. on March 9, 2019
Directions are inside.



Orbits and Positions of Farout (2018 VG18) and some other notable bodies (Wikipedia)

OKLAHOMA SPACE ALLIANCE OUTREACH March 2019

March Meeting:

Oklahoma Space Alliance chapter of National Space Society will meet at 2:00 p.m. on March 9, 2019 at Tom and Heidi Koszoru's house in Norman. Prospective members are also welcome. The house is at 514 Fenwick Court in Norman. Prospective members are also welcome.

To get the meeting either: (1) Take the Robinson Street west exit off I-35. Proceed west to 36th Street where you will turn left and go south until you turn left on Rambling Oaks (about half a mile north of Main Street). Fenwick Court is the third street on the left. Tom's house is the last on the left side, or (2) Take the Main Street west exit off I-35, proceed west past the Sooner Fashion Mall, and turn right at 36th Street, and go north until you turn right on Rambling Oaks (about half a mile north of Main Street). Fenwick Court is the third street on the left. The Koszoru house is the last on the left side.

Saturday March 9, 2019

Program

Place: Tom and Heidi Koszoru's house

514 Fenwick Court

Norman, OK 73072

- 1) Introductions and review of Space events this past month
 - a. What's Happening in Space, News, Pictures, and Videos approximately one hour.
- 2) Break
- 3) Oklahoma Space Alliance Chapter Business Discussion
 - a. Review OSA treasurer's report
 - b. Summary of February meeting minutes
 - c. Discuss proposal to sponsor an international sister chapter
- 4) Video: TBD given at the International Space Development Conference last May, in Los Angeles, CA. approximately 45 minutes
- 5) Chat

Minutes of February Meeting

Oklahoma Space Alliance met the McMurrays' house in Norman, Oklahoma on February 9. We were to meet at Zio's but discovered that we got our signals crossed and nobody reserved the room. In attendance were Clifford and Claire McMurray, Mary Creasey, Adam Hemphill, Mike Hopkins, John Northcutt, Tim Scott, Dave Sheely, Brian Swift, Steve and Karen Swift, and Syd Henderson. OSA President Clifford McMurray presided over the meeting. He also did an *Update* with links to the videos he presented. This can be found at <http://osa.nss.org/Update1902.pdf>, so I'll cover the highlights.

This was Adam's first meeting. He goes to the Mars Society.

We watched a video of the test of the SpaceX Raptor flight engine. They will be creating Starhopper and have 21 flights scheduled for 2019. "Starship" is the name of the upper part of the rocket.

The Dragon capsule will have two crew members for the test flight and carry seven people when in full service.

We watched a video of the SpaceShipTwo launch,

Astronaut wings for the SpaceShipTwo crew members (and presumably future customers of SpaceX) have "Commercial Space Transportation" on them.

Kip (Clifford) mentioned that these suborbital companies are going to make a great deal of their money by flying experiments.

We watched a video of a January 23 launch on New Shepard. It was the fourth flight for this launch vehicle.

The Lunar Reconnaissance Orbiter has been operating since 2009. It recently photographed the *Chang'e 4* lander (but couldn't see the rover). We watched a video of *Chang'e 4* landing on the Moon.

Chris Hadfield is doing online masterclasses on Space Exploration.

We watched a video of how to take space debris out of orbit.

We watched a video of the damage to the Columbus module of the ISS.

We watched a video about NASA cybersecurity threats during the government shutdown. NASA is the most attacked agency in the federal government.

We watched an ad of Mark Watley (Matt Damon) for Under Armor

Business:

Our annual report to the NSS is due of February 15 of each year. Syd does the report of chapter activities and made some corrections at the meeting. Among other things were a world space week talk on October 8.

Kip will not be able to attend Soonercon. Syd will try to do some panels.

We have \$963.95 in checking account and \$267 in cash for a total of \$1230.95.

The NSS website has changed to <https://space.nss.org>. We visited the new site.

We watched a Mars Society debate on the proposed Lunar Gateway launch platform at the Earth-Moon L1 point. (That's the one between the Earth and the Moon.) John Mankins took the affirmative side and Robert Zubrin the negative. Zubrin appeared to have the better of the debate.

--Minutes by OSA Secretary Syd Henderson

--Minutes by OSA Secretary Syd Henderson

Space News

At 1:4 a.m. on March 2, SpaceX made history with the first launch of its Crew Dragon capsule to the International Space Station. Although this was an unmanned test, Demo-1 was the first commercial spacecraft designed to carry crew to achieve orbit. It also successfully docked with the International Space Station at 4:51 a.m. CST on March 3. This mission is the first step in the resumption of manned spaceflight by American spacecraft since 2011. All manned missions to the ISS since then have been on Russian spacecraft. The next manned American spacecraft to achieve orbit is also scheduled to be a SpaceX Crew Dragon capsule in July.

SpaceX is running about a month ahead of Boeing, which is expected to launch an unmanned Starliner crew capsule to the Space Station in April and a manned capsule in August. Note though that there have been numerous postponements of the crew capsule tests by both SpaceX and Boeing, so those are really the earliest possible dates.

This mission was the first to use the international docking adapter since it was installed in August 2016. On board was a dummy astronaut named Ripley (after Sigourney Weaver's character in *Alien*) and a plush toy.

NASA Administrator Bridenstine sent congratulations: "Today's successful launch marks a new chapter in American excellence, getting us closer to once again flying American astronauts on American rockets from American soil "I proudly congratulate the SpaceX and NASA teams for this major milestone in our nation's space history. This first launch of a space system designed for humans, and built and operated by a commercial company through a public-private partnership, is a revolutionary step on our path to get humans to the Moon, Mars and beyond."

On February 21 a SpaceX Falcon 9 rocket carried a host of satellites into space, including a two-ton Indonesian communications satellite, *Nusantara Satu* and the half ton-Israeli *Beresheet* lunar lander. *Beresheet*, if successful, will be the first private spacecraft to land on the Moon, make Israel the fourth nation to achieve a soft landing on the Moon. (The Israel Space Agency did contribute some money to the launch.)

Beresheet (originally named "Sparrow") was SpaceIL's contestant for the Google Lunar X Prize. They didn't make the deadline for winning the X Prize but continued to work on the craft.

Beresheet is using a technique that I believe was originally used by the Japanese: instead of going directly to the Moon, it will increase its apogee through several orbits until its orbit is high enough for the Moon to capture it. This saves fuel at the expense of time: It will take *Beresheet* six weeks to get to lunar orbit, where it will arrive on April 4, and it will land on April 11 or 12. (I've seen both dates, which may reflect time zones.) If it lands on April 12, that will give Israel more reason to celebrate Yuri's Night.

The mission is only expected to last four or five days, finally succumbing to heat. However, it does carry an instrument for measuring lunar magnetism and a laser reflector donated by NASA which will continue to be used after the mission is over. There may be an attempt to move *Beresheet* five hundred meters (one of the requirements for the X Prize) by using its engines to hop across the surface of the Moon.



Figure 1 Beresheet Moon Lander (Israeli Space Agency)

Beresheet will have more company on the Moon as India is expected to launch *Chandrayaan-2* sometime in April. Since this is using the same orbit raising technique as *Beresheet*, we can expect it to be captured by the Moon in late May or early June, with a Moon landing in June. This will make India the fifth nation to achieve a soft Moon landing.

Well that didn't last long. On December 17, scientists at the International Astronomical Union's Minor Planet Center announced the discovery of the (then) most distant natural object yet observed in the Solar System. 2018 VG₁₈ was promptly nicknamed "Farout," partly because "Ultima Thule" was already taken. Farout is about 120 AU¹ away, or four times the distance of Neptune, three times the average distance of Pluto, and twice the average distance of Eris (Note though that Eris was observed at a distance of 96 AU when discovered, which made it the most distant solar system object observed before Farout). Farout is about 310 miles in diameter, which is a third the diameter of Pluto, and although set a new record for the distance at which it was observed, it is in the outer part of its orbit, with an aphelion of 169 AU and a perihelion of 22 AU, well inside the orbit of Neptune. There are a number of distant world that go much farther out than Farout.

For instance, on February 21, Scott Sheppard of the Carnegie Institution for Science in Washington, DC, announced the discovery of an object which is currently about 140 AU (150 million miles) from the Sun, though the exact distance is still uncertain, other than being more distant than Farout. In fact, this discovery is so new that its orbit and size haven't been determined. The new object has been dubbed FarFarOut, which suggests a disturbing trend.

A word of caution here: Although FarFarOut and Farout are the most distant natural objects in the Solar System observed through the telescope, there are many objects that go beyond their current distance, including Sedna, which gets out to 937 AU, "The Goblin" which gets almost to 2000 AU, and 2012 DR₃₀ (which doesn't seem to have a cute nickname) gets out almost to 3200 AU. The record holder among minor planets appears to be 2017 MB7, which gets out beyond 8000 AU, but it is only four miles in diameter, and I suspect it's really a comet. There are several comets that get farther than that, including Comet West which may get out to 70000 AU. (I'm not counting 'Oumuamua, which is going out of the Solar System altogether, and artificial objects such as the *Voyager* and *Pioneer* probes, and *New Horizons*, which are also headed out of the Solar System.)

And Planet 9, should it exist, would lie at an average distance of 600 AU. Farout and FarFarOut were discovered as part of the search for it.

The *Insight* Mars lander has a small problem: although it was landed in an area apparently free of boulders, its drill has hit a rock buried a few inches beneath the spacecraft. The drill managed to knock some small rocks out of its way but hit a larger one twenty inches below the surface. Although it should be possible to drill through this rock, it can only operate for four hours a day, after which it must cool for two days.

¹ An astronomical unit, or AU is the average distance of the Earth from the Sun, about 93 million miles.

Japan's *Hayabusa2* spacecraft touched the asteroid Ryugu on February 21 long enough to shoot a tantalum bullet into the asteroid and collect dust from the asteroid. It can repeat the maneuver a couple of times, but a more spectacular experiment will be to set off a small impactor full of explosives to create a new crater, giving *Hayabusa2* a chance to gather material from the interior of Ryugu. *Hayabusa2* itself will be safely on the far side of the asteroid while doing this bit of cosmic vandalism but has a deployable camera to photograph the explosion.

Hayabusa will stay at asteroid Ryugu until December, then fly by Earth in December 2020 to drop off the sample return capsules. After that, it may take off to find another asteroid to raid for material.

The Japanese are testing a new gravitational wave detector that's a bit different than the three now operating. The Kamioka Gravitational Wave Detector (KAGRA), renamed from the Large Scale Cryogenic Gravitational Wave Telescope (LCGT), has two three kilometer (1.8 mile) long arms arranged in the usual L-shape, but cooled to -253 degrees Celsius, *i.e.* 20 degrees above absolute zero. The reason it is being supercooled is to eliminate molecular movement due to heat. Only one of its four mirrors was supercooled for the initial test.

The name KAGRA is derived from Kamioka and Gravitational, so it's not a true acronym. KAGRA is expected to be fully operational by the end of the year, joining LIGOs two detectors in Hanford, Washington and Livingston, Louisiana, and the Virgo Interferometer in the village of San Stefano a Macerata near Pisa, Italy. Having at least three detectors operational simultaneously enables scientists to pinpoint the location, including distance, of events producing gravitational waves.

Sky Viewing

The **Lyrid meteor shower** peaks on the night of April 21 -22. This shower typically shows ten to twenty meteors per hours, but unfortunately this year the Moon will be almost full and drown many of them out. On rare occasions, this meteor shower can produce a "meteor storm" with hundreds of meteors per hour. The last time that happened was 1982.

On May 5, the **Eta Aquariid** meteor shower peaks. This shower is expected to produce only a meteor an hour, but does it for a remarkably long time, from mid-April to late May. What is notable about this shower is that it is one of two associated with Halley's Comet, the other being the more prominent Orionids in October.

Mercury is currently not visible as it approaches inferior conjunction with the Sun on the Ides of March. Mercury will be at greatest western elongation before dawn on April 11, but since the ecliptic is at a shallow angle to the horizon at that hour, Mercury will not get more than five degrees above the horizon before twilight begins.

Venus is currently rising about two hours before the Sun and is about magnitude -4, which is half a magnitude less than it is at its brightest but it still the brightest object in the sky other than the Moon at that hour and is easily visible though getting low in the sky. Venus is currently on the far side of the Sun but won't be in superior conjunction until August.

Mars is high in the western sky at sunset. It's located in the constellation Aries, which is pretty dim. Mars itself is only magnitude 1.2 and is still moving away from Earth. Still, it is the brightest object in that constellation and sets around 11:00 p.m. This won't change much over the next couple of months except that Mars will dim a bit further to magnitude 1.4 and move into Taurus. At the end of March, Mars will pass three degrees below the Pleiades, then spend April between the Pleiades and Hyades. On the 16th of April, Mars will be north of Aldebaran, which will be brighter than Mars.

With Venus getting lower in the east at Dawn, **Jupiter** rules the early morning, rising about 2:00 a.m. CST (3:00 a.m. when Daylight Savings Time kicks in.), and 1:00 a.m. CDT by the end of March and 11:00 p.m. by the end of April. During that time its brightness increases from magnitude -2.0 to magnitude -2.5. It is currently in the southern part of Ophiuchus not far from Antares, the brightest star in Scorpius. Since Jupiter begins retrograde movement against the stars on April 10, it will remain in Ophiuchus for a while, eventually approaching Antares again.

Saturn is rising a couple of hours after Jupiter and shining at magnitude 0.6 in Sagittarius. It is the brightest object on a line between Jupiter and Venus, both of which are far brighter. Saturn will continue to rise two hours of Jupiter through the end of April, finally rising at 1:00 a.m. around April 30. It begins retrograde motion on April 29 and will remain in Sagittarius.

Since Jupiter and Saturn are in adjacent constellations and very gradually approaching each other in the sky, it's not surprising that there is a Great Conjunction coming up, but it will be a while. On December 21, 2020 the two planets will be only six minutes of arc apart. In other words, they will be separated by a fifth the width of the Moon's disk.

Uranus (magnitude 5.8) is low in the west after sunset and may still be visible with binoculars. It is near the border of Aries and Pisces. Uranus is about to disappear entirely since it is in conjunction with the Sun on April 22. **Neptune** was in conjunction with the Sun on March 7 and won't be visible even with telescopes until April. It has a conjunction with Venus on April 10, passing half a degree above Venus, but both will be low in the sky. [Finder charts for Uranus and Neptune are online at wwwcdn.skyandtelescope.com/wp-content/uploads/WEB_UrNep18.pdf.]

Information for this section comes from the March and April issues of *Sky & Telescope* and *Astronomy*, and from their websites.

Viewing Opportunities for Satellites (March 9 – April 13)

You can get sighting information at www.heavens-above.com, which allows you to get satellite-viewing data for 10-day periods and gives you a constellation map showing the trajectory of the satellite.

<https://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/JavaSSOP/JavaSSOP.html> gives coordinates at 20-second intervals from when the satellite rises, not from when it peaks. (This program requires Java. I'm currently using Internet Explorer to run it and making an exception for the site in the Java Control Panel.) 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 2, so I'm using Heavens Above for those. The *Sky & Telescope* web site carries ISS 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 -3.8, which it will on March 18, 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. I'm including data for Tiangong 2, which can get up to magnitude 1.0 at least.

Missions to and from the International Space Station or Tiangong-2 may change its orbit. The only launch to either station during this time period the Expedition 59 launch to the ISS on March 14.

ISS, 14 March 2019

Time	Position	Elevation
6:41 a.m.	336°	18°
6:42	355	30
6:43	37	39
6:44	79	30
6:45	99	19

ISS, 21 March 2019

Time	Position	Elevation
8:35 p.m.	218°	22°
8:36	209	41
8:37	137	73
8:38	63	41
8:39	55	22

ISS, 16 March 2019

Time	Position	Elevation
6:35 a.m.	304°	22°
6:36	295	40
6:37	223	70
6:38	153	40
6:39	144	21

Tiangong-2, 23 March 2019

Time	Position	Elevation
Appears from Earth's shadow		
6:28 a.m.	276°	25°
6:29	212	50
6:30	135	10

ISS, 20 March 2019

Time	Position	Elevation
9:27 p.m.	249°	20°
9:28	265	36
9:29	320	53
Vanishes into Earth's shadow		

HST, 27 March 2019

Time	Position	Elevation
9:08 p.m.	222°	20°
9:09	203	27
9:10	176	31
9:11	149	27
Vanishes into Earth's shadow		

Tiangong-2, 21 March 2019

Time	Position	Elevation
6:48 a.m.	299°	10°
6:52	26	82
6:55	115	10*
*Passes very close to Venus		

HST, 28 March 2019

Time	Position	Elevation
8:57 p.m.	225°	21°
8:58	206	28
8:59	171	32
9:00:00	150	28
9:00:32	140	24

Vanishes into Earth's shadow

HST, 29 March 2019		
Time	Position	Elevation
8:47 p.m.	228°	21°
8:48	209	28
8:49	181	32
8:50	153	28
8:51	134	20

HST, 30 March 2019		
Time	Position	Elevation
8:36 p.m.	230°	20°
8:37	212	26
8:38	183	31
8:39	155	27
8:40	137	20

HST, 31 March 2019		
Time	Position	Elevation
8:26 p.m.	231°	20°
8:27	212	26
8:28	186	30
8:29	159	26
8:30	141	20

Tiangong-2, 31 March 2019		
Time	Position	Elevation
8:52 p.m.	236°	10°
8:55	150	74
8:57	70	26

Vanishes into Earth's shadow

Tiangong-2, 1 April 2019		
Time	Position	Elevation
8:30 p.m.	255°	10°
8:33	336	59
8:36	57	10

ISS, 9 April 2019		
Time	Position	Elevation
8:24 p.m.	294°	20°
8:25	277	35
8:26	226	49
8:26:40	192	43

Vanishes into Earth's shadow

Tiangong-2, 10 April 2019		
Time	Position	Elevation
9:15 p.m.	299°	10°
9:18	27	80
9:19	105	50

Vanishes into Earth's shadow

Tiangong-2, 12 April 2019		
Time	Position	Elevation
8:52 p.m.	299°	10°
8:55	212	51
8:57	140	18

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 Hubble Space Telescope at 8:36 p.m. on March 30, measure five fist-widths west from due south, 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.

Space-Related Articles

The April issue of *Astronomy* commemorates the *Apollo 9* mission, which we did in the January issue of *Outreach*. Included are an interview with Rusty Schweickart, the Lunar Module Pilot for *Apollo 9*. (Although earlier Apollo missions had other people whose title was "Lunar Module Pilot," *Apollo 9* was the first to carry a lunar module and Schweickart was the first to pilot one.) In addition, Alison Klesman profiles Jim McDivitt in "Jim McDivitt: 10 Days in Orbit."

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>

Upcoming events:

March 14, 1 p.m.: Coverage of launch of ISS Expedition 59 – 60 from Baikonur via Soyuz. (Actual launch is at 2:14

p.m.) 7:15 p.m.: Docking coverage begins, (Actual docking is at 8:06 p.m.) 9:30 p.m.: Hatch opening and welcoming coverage begins. (Actual hatch opening will be approximately 10:10 p.m.)

March 22: ISS Spacewalk coverage. Beginning of walk time to be determined, but it will last around seven hours.

March 29: ISS Spacewalk coverage. Beginning of walk time to be determined, but it will last around seven hours.

Calendar of Events

March: Second launch of Falcon Heavy, this is carrying Arabsat-6A, a heavy communications satellite.

March 3 – 13: 50th anniversary of *Apollo 9*, the first test of the Lunar Module (in Earth orbit).

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

March 9: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

March 14: Mercury is at inferior solar conjunction.

March 14: Launch of Expedition 59 to the Space Station.

April: Boeing's CST-Starliner makes an automated uncrewed flight to the ISS.

April 4: The Israeli space probe *Beresheet* enters lunar orbit.

April 10: Neptune is 0.4 degrees northwest of Venus.

April 11 or 12: *Beresheet* lands on the Moon, making Israel the fourth country to achieve a soft landing on the Moon.

April 11: Mercury is at greatest western elongation, 27 degrees west of the Sun (hence is visible before sunrise). This is a poor elongation due to the shallow angle of the ecliptic with respect to the horizon.

April 12: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.

April 12: Yuri's Night: 58th anniversary of orbital manned space flight.

April 13: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

April 22-23: Peak of Lyrid meteor shower.

May 5: Peak of the Eta Aquariid meteor shower.

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

May 11: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.

May 18 – 26: 50th anniversary of *Apollo 10*, the second manned mission to orbit the Moon, and the first to test the Lunar Module in Moon orbit. Astronauts were Tom Stafford, John Young and Eugene Cernan.

June: Third launch of Falcon Heavy, this on the Space Test Program Flight 2 for the Air Force. This will carry 25 small satellites and a 5000 kg ballast mast which presumably will not be a Tesla Roadster.

June 7: Peak of the Arietid meteor shower.

June 9: Jupiter is at opposition.

June 12: Orion Ascent Abort-2 Test.

June 18: Mars is 0.3 degrees below Mercury.

June 23: Mercury is at greatest eastern elongation, 25 degrees from the Sun (hence is visible after sunset.)

July: SpaceX will carry two NASA astronauts to the ISS. If this happens as scheduled, this will be the first American spacecraft to carry astronauts to orbit since 2011 but note that this has been postponed several times.

July 2: Total eclipse of the Sun visible from South Pacific including Pitcairn Island, Chile and Argentina.

July 8: Saturn is at opposition.

July 20: 50th Anniversary of *Apollo 11* landing on the Moon.

July 24: Soyuz MS-13 launches to the ISS. This is the last Soyuz seat contracted by NASA.

August: Boeing's CST-Starliner makes its first crewed flight with three astronauts to the ISS. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

August 10: Mercury is at greatest western elongation, 19 degrees from the Sun (hence is visible before sunrise.)

August 12: Peak of the Perseid meteor shower.

August 13: Venus is at superior conjunction with the Sun.

Fall 2019: ALINA, the *Autonomous Landing and Navigation Module* will be launched aboard a Falcon Block 5, and land near the *Apollo 17* landing site in the Taurus-Littrow valley. It will carry two Audi lunar rovers which will try to locate *Apollo 17*'s Lunar Rover. For more information, see <https://ptsScientists.com/products/alina>.

September: Arrival of *OSIRIS-REx* at the near-earth asteroid 101955 Benu to return samples. For more information, visit <http://en.wikipedia.org/wiki/OSIRIS-REx> or <http://science.nasa.gov/missions/osiris-rex/>.

September 9: Neptune is at opposition.

October 2: First operational mission of Dragon 2 to the ISS.

October 15: Launch of *CHEOPS*, the European Space Agency's exoplanet studier, from Kourou, French Guiana by a Soyuz rocket.

October 19: Mercury is at greatest eastern elongation, 25 degrees from the Sun (hence is visible after sunset.)

November 11: Mercury transits the Sun. The transit pretty much lasts all morning.

November 28: Mercury is at greatest western elongation, 20 degrees from the Sun (hence is visible before sunrise.)

December: Launch of China's *Chang'e 5* lunar sample return mission. This will be the first such mission since 1976.

December 14: Peak of the Geminid meteor shower.

December 26: Annular solar eclipse visible in Saudi Arabia, Qatar, India, Sri Lanka, Indonesia, the Philippines and Guam.

Sometime in 2020 Launch of the European Space Agency's Euclid space telescope. This will map the distribution of dark matter and search for evidence of dark energy. The Euclid website is <http://sci.esa.int/euclid>.

Sometime in 2020: Launch of the Korea Pathfinder Lunar Orbiter by SpaceX. This will be South Korea's first lunar mission and will also include an impactor.

February 2020: Launch from Cape Canaveral of the European Space Agency/NASA Solar Orbiter (SolO), which will orbit the Sun at a distance closer than Mercury. Not to be confused with NASA's *Parker Solar Probe*. Web site is sci.esa.int/solarorbiter

March 24, 2020: Venus is in greatest eastern elongation, 46 degrees from the Sun (hence is visible after sunset.)

June 2020: [Moved from 2019] Maiden flight of the Space Launch System.

June 2020: NASA launches the Lunar IceCube, Lunar Polar Hydrogen Mapper, and Lunar Flashlight lunar orbiters. For more information, see https://en.wikipedia.org/wiki/Lunar_IceCube.

July 2020: United Arab Emirates launch the Mars probe *Hope*, aka as *Al-Amal* or the *Emirates Mars Mission*, from the Mohammed bin Rashid Space Center in Dubai. For more information, visit https://en.wikipedia.org/wiki/Hope_Mars_Mission.

July 2020: Launch of the *Mars 2020* space rover, which will arrive on Mars at the beginning of 2021. For more information, see https://en.wikipedia.org/wiki/Mars_2020 or <https://mars.jpl.nasa.gov/mars2020/>.

July 23, 2020: Launch of the Mars Global Remote Sensing Orbiter, Lander and Small Rover by China. For more information, see https://en.wikipedia.org/wiki/Mars_Global_Remote_Sensing_Orbiter_and_Small_Rover. (China really needs to work out an acronym for this.)

July 25, 2020: ESA launches the *ExoMars Mars Rover* For more information, visit en.wikipedia.org/wiki/Exomars.

August 13, 2020: Venus is in greatest western elongation 45 degrees from the Sun (hence is visible before sunrise.)

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

December 2020: Launch of the Korea Pathfinder Lunar Orbiter (KPLO) and lunar impactor from Naro Space Center in South Korea.

December 21, 2020: Great conjunction between Jupiter and Saturn. The two planets will be separated by six minutes of arc.

Sometime in 2021: *Hope*, aka *Emirates Mars Mission*, arrives at Mars (see July 2010).

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

March 30, 2021: [Moved yet again]: Launch of the James Webb Space Telescope.

October 29, 2021: Venus is in greatest eastern elongation 47 degrees from the Sun (hence is visible after sunset.)

Sometime in 2022: SpaceX plans to launch a human crew around the Moon. [This is speculative, reflected by this mission being postponed from 2018.]

Sometime in 2022: Proposed launch date of JUICE, the Jupiter Icy Moon Explorer, by the European Space Agency. The JUICE web site is <http://sci.esa.int/juice>.

June 2022: First crewed launch of an *Orion* space capsule.

Sometime in 2023: *OSIRIS-REx* returns with samples from the Asteroid Benu.

April 8, 2024: Next total eclipse of the Sun visible in the United States. This one will be visible on a path through northern Mexico (making landfall opposite the tip of Baja California), passes through Texas (including Dallas, Arlington

and Waco), touches the southeastern corner of Oklahoma, then crosses Arkansas, eastern Missouri, Illinois, western Kentucky, Indiana, Ohio (including Cleveland), Erie in Pennsylvania, upper New York (including Buffalo and Niagara Falls), Burlington in Vermont, New Hampshire, and Maine, then into Canada.

December 19, 2024: *Parker Solar Probe* (formerly *Solar Probe Plus*) makes its first pass through the outer corona of the Sun. For more information, see <http://parkersolarprobe.jhuapl.edu>.

December 2025: *BepiColombo* arrives at Mercury orbit.

Sometime in 2030: JUICE achieves Jupiter orbit. [See 2022.]

Sometime in 2033: JUICE achieves Ganymede orbit. [See 2022.]

August 12, 2045: The next total solar eclipse visible in Oklahoma City. This one is also visible in Salt Lake City, Denver, Little Rock (again), Tampa Bay and New Orleans.

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Other Information

Oklahoma Space Industrial Development Authority (OSIDA), 401 Sooner Drive/PO Box 689, Burns Flat, OK 73624, 580-562-3500. Website is <http://airspaceportok.com/#home>,

Science Museum Oklahoma (former Omniplex) website is www.sciencemuseumok.org. Main number is 602-6664.

Tulsa Air and Space Museum, 7130 E. Apache, Tulsa, OK 74115.

Web Site is www.tulsaairandspacemuseum.com. Phone (918) 834-9900.

The Mars Society address is Mars Society, Box 273, Indian Hills CO 80454. Their web address is www.marsociety.org.

The National Space Society's Headquarters phone is 202-429-1600. Executive Director e-mail nsshq@nss.org. The Chapters Coordinator is Bennett Rutledge 720-641-7987, rutledges@chapters.nss.org. The address is: National Space Society, PO Box 98106, Washington DC 20090-1600 Web page is space.nss.org.

The Planetary Society phone 626-793-5100. The address is 65 North Catalina, Avenue, Pasadena, California, 91106-2301 and the website is www.planetary.org. E-mail is tps@planetary.org.

NASA Spacelink BBS 205-895-0028. Or try www.nasa.gov.

Congressional Switchboard 202/224-3121.

Write to any U. S. Senator or Representative at [name]/ Washington DC, 20510 (Senate) or 20515 [House]

OKLAHOMA SPACE ALLIANCE
A Chapter of the National Space Society
MEMBERSHIP ORDER FORM

Please enroll me as a member of Oklahoma Space Alliance. Enclosed is:

_____ \$10.00 for Membership. (This allows full voting privileges but covers only your own newsletter expense.)

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National Space Society has a special \$20 introductory rate for new members. Regular membership rates are \$52, Student memberships are \$36, Senior \$42. Part of the cost is for the magazine, *Ad Astra*. If you choose to receive the magazine digitally, memberships are \$40 for regular, \$24 for students and \$30 for seniors. Mail to: National Space Society, PO Box 98106, Washington, DC 20090, or join at www.nss.org/membership. (Brochures are at the bottom with the special rate.) Be sure to ask them to credit your membership to Oklahoma Space Alliance.

To join the Mars Society, visit www.marssociety.org. One-year memberships are \$50.00; student and senior memberships are \$25, and Family memberships are \$100.00. Their address is Mars Society, 11111 W. 8th Ave, Unit A, Lakewood, CO 80215.

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