

OKLAHOMA SPACE ALLIANCE

OUTREACH – July 2015

102 W. Linn #1, Norman, OK 73069



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

OUTREACH July 2015

July Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, July 11, 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.

Our PlutoPalooza celebration has been moved to the August meeting because we couldn't get a room at one of the local libraries. There will certainly be a lot about the *New Horizons* mission to Pluto at the July meeting since the flyby is Tuesday the 14th and we'll already be getting good pictures by the 11th and presenting them at the meeting.

Oklahoma Space Alliance Meeting Program

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

- 1) What's Happening (Steve Swift)
 - Current Space News, Pictures, Videos & Links
 - Includes: Pluto Flyby, SpaceX Explosion, ISS Supply
- 2) Discuss Common Interests with Students for
Exploration and Development of Space
- 3) Discuss Business
 - a. Summary of June Meeting
 - b. Review OSA Accounts
- 4) Pluto Party
 - c. Date
 - d. Location
- 5) OSA Charter
- 6) OSIDA Meeting Report
- 7) Chat

Minutes of June Meeting

Oklahoma Space Alliance met at Earl's Rib Palace in Moore on June 9. In attendance were Steve, Brian and Karen Swift, Dave Sheely, Jerry, Rachelle and Stephanie Thibedeau. Vickey Richartz, Tim Scott, Russ Davoren, Dennis Wigley, John Northcutt, Richard Holtzschue, Will Decker, Claire and Clifford McMurray, and Syd Henderson. We had several guests from the new OU SEDS chapter, including Eric S4undby, Michelle and Frederick Rodriguez and Jordan Little.

We currently have \$1014.70 in our checking account and \$267 on cash, for a total of \$1281.70.

SpaceX is now certified to launch national security space missions. This puts them in competition with the United Launch Alliance. SpaceX will be so much cheaper than ULA that ULA may not be in competition in five years.

The Air Force's X-37B is an unmanned mini-shuttle about 29 feet long, about the size of a small school bus. For some details, see www.usatoday.com/story/news/nation/2012/12/09/x37b-mystery-mini-shuttle/1756923/.

The Chinese are applying to fly on XCOR's Lynx spacecraft.

Airbus's Adeline has an engine section that can fly itself back to a runway.

We watched a video of a Falcon 9 launch and its landing attempt.

The US Senate said no to military contractors using Russian RD-180 rocket engines. This is a blow to the United Launch Alliance, who uses them to launch Atlas V rockets which carry military satellites to orbit. ULA had made a request to buy more engines, but Senator McCain, who chairs the Senate Armed Services Committee, turned them down. [There was already a moratorium on buying them due to Russia's invasion of Ukraine. ULA has a dozen coming from a previous contract, but otherwise they will have to wait for their new Vulcan rockets, which use American made engines, to come on line in 2022.]

NASA has a detector called "Finder" that was used in Nepal to detect the heartbeats of Nepalese trapped under debris after the recent earthquake.

The Shackleton Energy Company is forming a consortium with 100 partners to create a lunar base to mine water. The overhead is \$18 billion.

NSS Chapters are free to take a position on the Space Launch System provided they make it clear that it is a chapter position and not that of the NSS as a whole.

Oklahoma Space Award won an NSS award for excellence in public outreach. It is on the meet-up site but not yet on the website.

Claire will be talking at SoonerCon with Larry Nemecek about Enterprise in Space.

There will be an interview with a person on the *New Horizons* Pluto project in the next issue of *Ad Astra*.

Since our next meeting time is close to the Pluto flyby, do we want to have a Pluto observation party instead?

Note on OSIDA Meeting

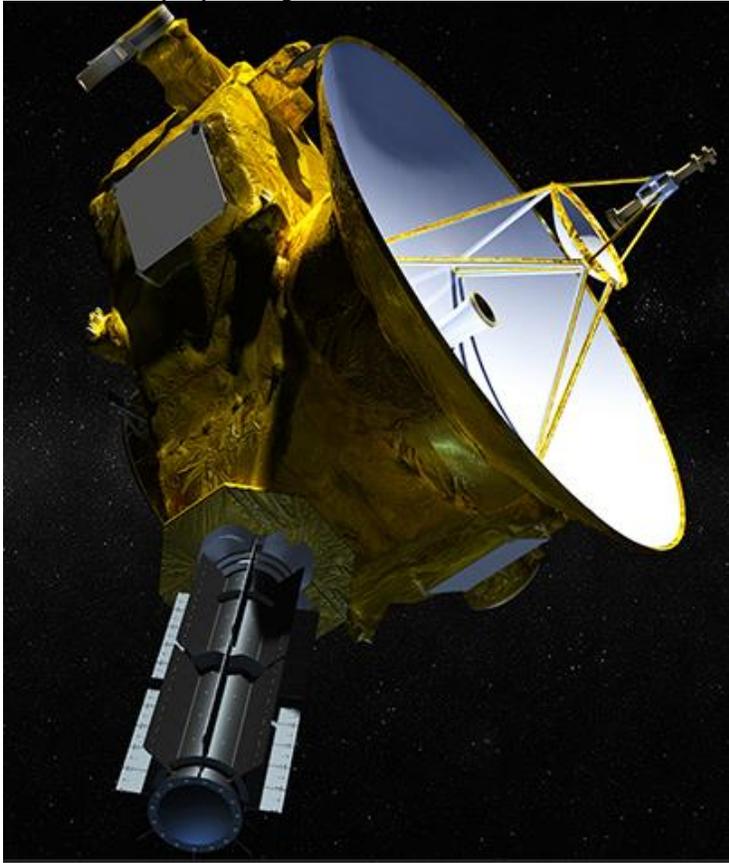
The Oklahoma Space Industry Development Authority didn't have its June meeting due to lack of a quorum. Since this would have been the meeting at which officers are selected, that will be done at the July meeting.

Space News: Encounter with Pluto

On July 14, the *New Horizons* spacecraft will finally reach the culmination of its nine-year mission when it flies through the Pluto-Charon system on its way through the Kuiper belt. It already has sent us the best pictures we've ever had of Pluto and its moons, including the first indications of surface features on Pluto's moon Charon.

The spacecraft gave space enthusiasts an "oh no" moment on July 4, when the probe handlers lost contact with it at 12:54 p.m., but they were able to restore contact at 2:15 p.m. The autopilot had encountered some problem, went into safe mode and switched to the backup computer which reinitiated contact. (Since Pluto is 4.5 light-hours away, this had to be done

automatically by the spacecraft.) Mission



officials said the spacecraft is healthy, but it may take several days to complete recovery, during which *New Horizons* will be unable to transmit data. Latest word is that the source of the glitch was a command that will not be repeated during the encounter, and operations will resume on Tuesday, July 7 (the day I am writing this newsletter). This will give NASA a full rotation of Pluto and Charon (and also a full orbit since they are tidally locked) as *New Horizons* approaches.

New Horizons was the fastest probe ever launched from Earth, but still required a gravity assist from Jupiter to reach its destination in a reasonable time. This is probably a one-shot for our lifetimes since Jupiter won't be in the right place for 200 years for the gravity assist. [Although, I suppose if we find something extremely interesting at Pluto, we could rig up a new kind of spacecraft and wait patiently for a good long time.] Since we won't have another spacecraft entering the Kuiper Belt for the foreseeable future, *New Horizon's* team is anxiously looking for other Kuiper Belt objects it might target. They have to be within a degree of *New Horizon's* path and no farther than 55 astronomical units from the Sun, because the communications link will have decayed too much by then to allow much data to be transmitted. Objects should be at least 50 km in diameter and a different hue than Pluto and Charon. Objects that can't be seen from ground-based telescopes, but three at least have been discovered by the Hubble Space Telescope. Two of them, designated 2014 MT₆₉ and 2014 PT₇₀ are being considered. The first is easiest to get to, but the second is brighter and presumably larger.

After the Kuiper Belt mission, *New Horizons* will join *Voyager 1* and *Voyager 2* in exploring the heliosphere and heliopause. It will not, however, overtake those elderly spacecraft despite having a faster launch velocity because the Voyagers gained so much speed from their

gravitational assists.

New Horizons has already shown Pluto and Charon to be interesting worlds with varied surface features. Pluto has long been known to have bright and dark patches and Charon looks like it might also. Pluto has a series of four evenly spaced blotches, each about 300 miles wide, along its equator, looking like a series of finger holes each the size of Missouri, although they're presumably craters or the Plutonian equivalent of maria, but nobody knows yet. There also appear to be a lot of darkness in the southern hemisphere, and various dark patches like frozen oceans. There's also indication of a polar cap.

Pluto has a 1900 mile long dark area on its equator which makes Pluto not look round in some pictures. It's nicknamed "the whale." Directly east of this is a thousand-mile wide area that is the brightest on the planet,

We don't have as much data for Charon, although the north pole seems to be dark. Pluto's surface varies between white, orange and black, while Charon seems to be various shades of grey and black. Presumably the difference in color is due to Pluto's ability to retain methane (which can interact with ultraviolet light to produce colored compounds), while Charon's surface is mostly water ice, but ammonium hydrates have also been detected. Pluto's surface also contains frozen nitrogen and carbon monoxide.

Because of Pluto's axial tilt, we won't get to see all of its surface in sunlight; one of its poles is currently experiencing a night over a hundred years old. *New Horizons* will try to image this region by Charon light.

Charon is large enough to be rounded by gravity. If it were an independent body, it would be considered a dwarf planet in its own right. As it is, the center of mass of the Pluto-Charon system lies outside of Pluto, which leads some astronomers to consider them a double dwarf planet.

The system also has four small moons, named Hydra, Nix, Styx and Kerberos. Kerberos's name is spelt that way to distinguish it from the asteroid 1865 Cerberus. Nix is an alternate spelling for Nyx, the Greek goddess of Night (and Charon's mother); the Latin equivalent is Nox. Nyx was already used for asteroid 3908 Nyx. Styx is a river of Hades and a once popular rock band. Hydra's also the name of a constellation, and the Hydra itself didn't have anything to do with Hades. Apparently it got the name because the Hydra had nine heads (before they started duplicating) and Pluto was the ninth planet at the time.

There are odd things about the orbits of the moons of Pluto. Going out from Pluto, the moons are Charon, Styx, Nix, Kerberos and Hydra, and they are nearly (but not exactly) in orbital resonance of 1:3:4:5:6. However Styx, Nix and Hydra are in a resonance of 18:22:33, which means Styx orbits eleven times for every nine of Nix and six of Hydra. As with the three inner Galilean satellites, triple conjunctions never occur, although it is possible for Styx to be directly opposite Nix and Hydra.

Since Pluto and Charon are relatively large and close to each other, and the other moons aren't all that distant, the small moons of Pluto are subjected to strong tidal forces. Nix and Hydra are also elongated in shape, which means that they rotate chaotically. Kerberos seems to be rounder so may have a regular rotation. We don't have enough about Styx to venture a guess.

The smaller moons are now believed to have been captured by Pluto and Charon. Kerberos is much darker than the other moons, which may mean that it was captured from a different part of the Kuiper Belt.

Although prior to the mission, it was assumed that *New Horizons* might find more moons or possibly rings, it's now considered unlikely because of the resonance effects of the Moons already there, which probably have prevented any further captures.

Here's some information from Claire on television coverage of the New Horizons mission:
FYI:

New Horizons will fly past Pluto on Tuesday July 14, but it can't phone home until a few hours later. This will not happen again in your lifetime* because the necessary speed requires a gravity assist from Jupiter, which won't be in the right place again relative to Earth & Pluto for about 200 years.

You can watch at home; there are TV specials scheduled on:

Tue. July 14, 9 pm ET/8 pm CT: National Geographic Channel, "Mission Pluto"

Wed. July 15 7 pm ET/6 pm CT, Discovery Channel, "Pluto: First Encounter"

Wed. July 15, 9 pm ET/8 pm CT, PBS Nova, "Chasing Pluto"

[Also Wed., July 15, 9:00 p.m. CT, Science Channel "Direct from Pluto: The First Encounter.]

Since the New Horizons spacecraft is getting so close, there's already info at:

- <http://www.nasa.gov/feature/new-horizons-color-images-reveal-two-distinct-faces-of-pluto-series-of-spots-that-fascinate>
- <https://solarsystem.nasa.gov/planets/plutotoolkit.cfm>
- <http://pluto.jhuapl.edu/> and <http://pluto.jhuapl.edu/Participate/teach/Activities.php> ;
- <https://www.youtube.com/watch?v=shCLLMieK4g> ("Passport to Pluto," from NOVA SpaceNow)

I'll be at the encounter while they're filming, but presumably they'll be aimed at the scientists, not the press group.

Claire

* Barring something like fusion drive or doubling lifespan.

NASA is also having a daily update through the 12th at 10:30 a.m. on NASA TV. Also see the NASA TV on the Web information late in this newsletter.

Note, however, that there will be no pictures coming on the evening of the 13th or during the day on the 14th, since *New Horizons* will be busy taking pictures and won't transmit them until after the flyby. It will make up for that by sending data back well into next year.

Space News

SpaceX suffered a severe setback on June 28 when an unmanned Falcon 9 spacecraft broke apart two minutes and nineteen seconds after liftoff on a cargo mission to the International Space Station. This was the third time in eight months that a cargo ship to the ISS was lost, after the explosion of an Antares last October 28, and the failure of a Russian Progress launched on April 28 to reach the ISS. At this point, I would consider not launching rockets to the ISS on the 28th.

Elon Musk says the explosion appears to be due to overpressurization of the oxygen tank on the upper stage, but that that is far from definite. The Dragon capsule appeared to have survived the explosion to fall into the Atlantic.

The astronauts aboard the Space Station did get resupplied by a Russian Progress spacecraft on July 5, and will get another supply mission from Japan in August. Orbital Services will try again later this year, this time on a United Launch Alliance rocket.

Although the explosion of the SpaceX Falcon 9 is going to cause difficulties while they search for the cause, NASA is not concerned about the company's ability to fly astronauts by the end of 2017. Funding problems are more likely to cause a delay as Congress wants to cut a couple hundred million dollars from the Commercial Space Program, which is \$1.2 billion to begin with.

In happier news, the European Space Agency's Philae comet lander woke up on June 13. The first signal, only 85 seconds long, was the first received from Philae since November 14. Since Philae also sent some data stored over the previous weeks, it was already awake, just not able to contact the ESA. Contact has been intermittent because it has to go through the *Rosetta* spacecraft, Comet 67P/Churyumov-Gerasimenko rotates once every 12.4 hours, and Philae's only visible to *Rosetta* for three hours at a time. *Rosetta* cannot approach the comet too closely because the comet is spewing dust, but on June 30, it was moved within a hundred miles of the comet.

Meanwhile, *Rosetta* has spotted holes on the comet up to a thousand feet across. These are nice and circular and up to six hundred feet deep. Some of these are spewing dust but not enough to account for them. It's thought that these might be sinkholes caused when the roof of a cavity collapses under the force of gravity. It's strange to think that the weak gravity of Comet 67P could do such a thing.

If this hypothesis is correct, we still need an explanation of how the cavities occurred. An obvious candidate is long-term sublimation of volatiles such as water ice or carbon dioxide ice. Alternatively, they could have been born with the comet. This last hypothesis would gel with the observation that more than three-quarters of the comet's volume is empty space. Indeed, the comet looks like two smaller comets collided at a slow velocity and stuck together. (If they'd collided at a higher velocity, the comet would become hotter and lost even more volatiles.)

There have been some headlines, especially in England, about a couple of astronomers at British universities claiming that Comet 67P probably harbors alien microorganisms. The first evidence is the presence of dark matter that is rich in organic chemicals and the second is that *Rosetta* has picked up some virus-like particles. However, the first could simply have been formed by cosmic rays and ultraviolet light striking the surface of the comet. As for the second, we'd need to know what "virus-like" means. It's long been known that comets can contain fairly complex organic molecules, to the point that one theory claims that they may have brought the building blocks of life to Earth. However, extraordinary claims require extraordinary proof, which we don't have in this case.

The United Arab Emirates have announced plans to launch a Mars Orbiter, *Hope* in the summer of 2020. It would primarily measure water ice and vapor, dust and ozone in the Martian atmosphere. For more information, visit <http://mbrsc.ae/en/page/mars-probe>.

A group of scientists led by Yongsheng Chen at Nankai University discovered while cutting graphene sponge (made by combining layers of graphene oxide), that the material is unusually easily propelled by lasers, and even by concentrated sunlight. There seems to be some sort of photoelectric effect involved, since the propulsion is greater than that which should be produced by light alone.

If this force also works in space, it's possible that graphene sponge might be an ideal substance for solar sails. (*New Scientist*, 30 May 2015, page 12.)

Our Pluto has submitted its list of candidate names for features on Pluto. You can view them here: <http://www.ourpluto.org/pluto>. I like the underworld themes and the historic explorers, which include Hillary and Norgay, Cheng He and Cousteau.

Sky Viewing

[Material for this section of *Outreach* comes from the July and August issues of *Astronomy* and *Sky & Telescope*, and the *Sky & Telescope* web site.]

The **Perseid Meteor Shower** peaks on the night of August 12-13, with the best viewing on the early morning of the 13th. However, meteors will be visible for several days before and after the peak. This year the New Moon is on August 14, so conditions will be perfect for viewing. The radiant is in northern Perseus and rises about 10:00 p.m.

The Perseids are debris from Comet Swift-Tuttle, which has a period of 130, last appearing in 1992. This year, Earth will be passing very close to the debris shed from the comet's previous appearance in 1862, so there may be more meteors than usual. Even if not, expect about 100 meteors per hour at the peak.

The dwarf planet **Ceres** is at opposition on July 25, peaking at magnitude 7.5. It is currently located near the boundary of Capricornus, and the obscure constellation Microscopium. (Constellations named after scientific instruments tend to be obscure.) It's moving toward Sagittarius, which it will enter later this month and pass through in August. It will actually be 8th magnitude through much of July and August. There are star maps on page 42 of the July *Astronomy*, page 43 of the August *Astronomy*. You can also find it online using the sky charts https://in-the-sky.org/news.php?id=20150725_14_100.

Ceres is of special interest at the moment because the *Dawn* spacecraft is slowly lowering its orbit and we are getting better pictures. It's being upstaged this month by its fellow dwarf planet **Pluto**, which is also in Sagittarius, but much dimmer, only 14th magnitude, and you'd need an 8-inch telescope to find it. There's an article on pages 46 – 47 of the July issue of *Astronomy* with charts to help you locate it. There's also a finder chart on page 52 of the July *Sky & Telescope*, and online at http://www.skyandtelescope.com/wp-content/uploads/WEB_2015_Pluto.pdf. The interactive charts at <https://in-the-sky.org> may also be helpful. Pluto was at opposition on July 6, so this is the brightest it gets all year.

Venus and **Jupiter** had a very close conjunction in late June and are still prominent in the evening sky and separated by a few degrees. Venus is magnitude -4.7, easily the brightest object in the night sky other than the Moon. Jupiter is magnitude -1.8, and sets a couple of hours after sunset, with Venus following a few minutes later. They are currently in the constellation Leo, and the first magnitude star Regulus is to their upper left.

Viewing conditions for both will deteriorate over the next month because Venus is approaching inferior conjunction with the Sun on August 14 and Jupiter on August 26. Both should still be visible at twilight at the beginning of August, and Venus should appear in the morning sky in late August.

Mercury is visible in the eastern sky just before sunrise and will brighten to magnitude -1.0 during the second week of July. It then fades rapidly, reaching superior conjunction with the Sun on July 23. Mercury will become visible after sunset in early August. On August 6, Mercury and Jupiter will be separated by about the width of the Moon. Jupiter will be magnitude -1.7 and Mercury magnitude -0.7, but Mercury will be higher. Regulus is also nearby, and on August 11, Jupiter and Regulus will be separated by less than the diameter of the Moon.

Mars was in conjunction with Sun on June 14 and is not currently visible and won't be until late August. It's also on the far side of the Sun and even then won't be much more than magnitude 1.7.

Saturn is magnitude 0.3 in the constellation Libra and is in fact the brightest object in that area of sky. It's currently in the southern sky at sunset, about thirty degrees above the horizon. It will be located about thirteen degrees above Antares for the entire month of August. In mid-August, Saturn will be the only bright planet that isn't drowned out by twilight.

Uranus is currently rising about 2:00 a.m., but will be rising at midnight around the end of the month. It's magnitude 5.8, which makes it barely visible to the naked eye under ideal conditions. It's located in the lower part of Pisces among some 6th magnitude stars, about thirteen degrees from the Circlet. It's also only about seven degrees to the upper left of the dwarf planet Eris. However, the latter is magnitude 18.6, making it invisible in anything less than a very powerful telescope.

Neptune rises about two hours before Uranus and is magnitude 7.8, well below naked-eye visibility though it should be visible through binoculars and small telescopes. It's in the constellation Aquarius, where it will be for years. There are several visible stars nearby, none of them particularly conspicuous, though they are bright enough to have names from the Greek alphabet.

Neptune's nearing opposition, which it will reach on August 31. At that time it will be halfway between Lambda and Sigma Aquarii. Lambda Aquarii is magnitude 3.8 and is ten degrees southeast of an asterism called the Water Jug. Neptune is 3.4 degrees southwest of Lambda Aquarii.

There are finder charts for Uranus and Neptune at www.skyandtelescope.com/wp-content/uploads/WEB_UrNep_Finders.pdf. To tell the truth, neither planet moves much over a year, so if you find them one night, they'll still be there the next night.

Viewing Opportunities for Satellites (July 11 – August 11, 2015)

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. The next manned launch to the Space Station is Expedition 44 on July 22.

ISS 1 July 13, 2015			HST July 24, 2015		
Time	Position	Elevation	Time	Position	Elevation
Appears from Earth's Shadow			5:46 a.m.	229°	20°
5:11:04 a.m.	224°	30°	5:47	210	27
5:11:32	223	43	5:48	184	30
5:13	145	85	5:49	158	27
5:14	51	41	5:50	139	20
5:15	49	21			

Tiangong 1 July 13, 2015			HST July 25, 2015		
Time	Position	Elevation	Time	Position	Elevation
9:44 p.m.	304°	10°	5:38 a.m.	230°	19°
9:47	22	50	5:39	212	25
9:50	95	16	5:40	189	29
Vanishes into Earth's Shadow			5:41	161	25
			5:42	143	19

Tiangong 1 July 15, 2015			ISS July 30, 2015		
Time	Position	Elevation	Time	Position	Elevation
9:20 p.m.	297°	10°	10:54 p.m.	271°	16°
9:23	25	87	10:55	291	24
9:26	116	11	10:56	325	30
			10:57	355	24
			10:58	18	16

HST July 23, 2015			ISS July 31, 2015		
Time	Position	Elevation	Time	Position	Elevation
5:55 a.m.	227°	20°	5:23 a.m.	317°	22°
5:56	209	27	5:24	323	41
5:57	182	31	5:25	39	78
5:58	154	27	5:26	120	41
5:59	135	20	5:27	126	21

ISS July 31, 2015		
Time	Position	Elevation
10:00 p.m.	244°	21°
10:01	257	38
10:02	318	60
10:03	21	38
10:04	35	21

ISS August 3, 2015		
Time	Position	Elevation
8:57 p.m.	251°	20°
8:58	268	34
8:59	320	50
9:00	18	35
9:01	30	20

ISS August 1, 2015		
Time	Position	Elevation
9:07 p.m.	210°	20°
9:08	196	38
9:09	138	59
9:10	74	37
9:11	61	20

Tiangong 1 August 7, 2015		
Time	Position	Elevation
Appears from Earth's Shadow		
5:58 a.m.	254°	13°
6:00	335	63
6:03	88	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 ISS at 9:01 p.m. on August 3, measure three fist-widths east from north, the 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:

July 10, 10:30 a.m.: Update on New Horizons/Pluto Mission.

July 11, 10:30 a.m.: Update on New Horizons/Pluto Mission. Noon and 7:00 p.m., "The Year of Pluto-A Documentary".

July 12, 10:30 a.m.: Update on New Horizons/Pluto Mission. 7:00 p.m., "The Year of Pluto-A Documentary".

July 14, 4:30 a.m.: Live interview with NASA Administrator Charles Bolton on Pluto Mission. 6:30 a.m.: New Horizons Mission Celebration. 8:15 a.m.: Interview with Charles Bolton. Noon: "The Year of Pluto-A Documentary".

July 15, 5:00 a.m. and 11:00 a.m.: Live satellite interviews on Pluto Mission. 2:00 p.m. New Horizons news conference.

July 17, noon: NASA news conference on New Horizons.

July 22: 3:00 p.m. Launch coverage of ISS Expedition 44. (Actual launch is 4:02 p.m.) 9:00 p.m.: Docking coverage. (Actual docking is 9:45 p.m.) 10:30 p.m.: Hatch opening coverage. (Hatch opening is 11:20 p.m.)

Calendar of Events

July 10: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). There will be a novice session in the planetarium at 6:45 p.m., followed by a club meeting at 7:30 p.m. See <http://www.okcastroclub.com/> for details.

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

July 14: The *New Horizons* probe passes through the Pluto-Charon system. The New Horizons web site is pluto.jhuapl.edu/.

July 18: The Moon occults Venus.

July 22: Astronauts Kjell Lindgren (NASA), Kimiya Yui (JAXA) and Oleg Kononenko (Roscosmos) are launched to the ISS at 4:00 p.m. CDT from the Baikonur Cosmodrome in Kazakhstan.

July 23: Mercury is in superior conjunction with the Sun.

July 28: Peak of Delta Aquarid meteor shower.

August 8: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

August 12: Peak of Perseid meteor shower.

August 14: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). There will be a novice session in the planetarium at 6:45 p.m., followed by a club meeting at 7:30 p.m. See <http://www.okcastroclub.com/> for details.

August 15: Venus is in inferior conjunction with the Sun.

August 17: Launch of JAXA's HTV5 Cargo Craft to the Space Station. This launch includes the Calorimetric Electron Telescope (CALET) and the Multi-User System for Earth Sensing (MUSES).

August 26: Jupiter is in conjunction with the Sun.

August 31: Neptune is in opposition.

September 1: Launch of Expedition 45 to the Space Station.

September 2: Launch of 8th SpaceX supply mission to the Space station.

September 4: Mercury is at greatest elongation, 27 degrees east of the Sun (so can be seen after sunset).

September 12: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

September 28: Total lunar eclipse visible from most of North America (including Oklahoma), all of South America, all but the eastern part of Africa, western Europe and the entire Atlantic Ocean.

September 30: Mercury is in inferior conjunction with the Sun.

October 11: Uranus is at opposition.

October 15: Mercury is at greatest western elongation, 18 degrees from the Sun (so can be seen before sunrise).

October 10: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

October 21: Peak of Orionid meteor shower.

October 26: Venus is at greatest western elongation, 46 degrees from the Sun (so can be seen before sunrise).

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

November: Japan's *Akatsuki* space probe flies by Venus and there will be a second attempt to achieve orbit.

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

November 14: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

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

November 17: Peak of Leonid meteor shower.

November 29: Saturn is in conjunction with the Sun.

December 12: [Tentative] Oklahoma Space Alliance meeting, 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).

Sometime in 2016: ESA launches the *ExoMars Mars Orbiter*. This mission will include a static lander, but the rover will be launched in 2018. For more information, visit en.wikipedia.org/wiki/Exomars.

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

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

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/>.

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.

June 6, 2016: Venus in superior conjunction with the Sun.

July 4, 2016: *Juno* arrives at Jupiter. The NASA *Juno* page is http://www.nasa.gov/mission_pages/juno.

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

July 9, 2016: The European Space Agency/JAXA *BepiColombo* Mercury Orbiter is launched. Home page is <http://sci.esa.int/bepicolombo>.

September 2016: 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/>.

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).

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

July 2017: Launch of the European Space Agency/NASA Solar Orbiter (SolO), which will orbit the Sun at a distance closer than Mercury. Web site is <http://sci.esa.int/solarorbiter>.

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

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.

July 30, 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.

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>.

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: The 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 Bennu to return samples. [See September 2016.]

April 8, 2024: A total solar eclipse crosses the US from the middle of the Mexico-Texas border, crosses Arkansas, southern Missouri, Louisville, Cleveland, Buffalo and northern New England.

December 19, 2024: *Solar Probe Plus* makes its first pass through the outer corona of the Sun. [See July 30, 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)

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E-mail for OSA should be sent to sydh@ou.edu. Members who wish their e-mail addresses printed in *Outreach*, and people wishing space-related materials e-mailed to them should contact Syd. Oklahoma Space Alliance website is chapters.nss.org/ok/osanss.html. Webmaster is Syd Henderson.

Other Information

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

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

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

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

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

The National Space Society's Headquarters phone is 202-429-1600. Executive Director e-mail nsshq@nss.org. The Chapters Coordinator is Bennett Rutledge 720-641-7987, rutledges@chapters.nss.org. The address is: National Space Society, 1155 15th Street NW, Suite 500, Washington DC 20005 Web page is www.nss.org.

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

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

Congressional Switchboard 202/224-3121.

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

OKLAHOMA SPACE ALLIANCE
A Chapter of the National Space Society

MEMBERSHIP ORDER FORM

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

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

_____ \$15.00 for family membership

_____ TOTAL amount enclosed

National Space Society has a special \$20 introductory rate for new members (\$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. (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, Box 273, Indian Hills CO 80454.

Do you want to be on the Political Action Network?

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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.**