OUTREACH September 2015

September Meeting:

Oklahoma Space Alliance will meet at 2:00 p.m. on Saturday, September 12, 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.

Agenda

1) What's Happening (Steve Swift)
   Current Space News, Pictures, Videos & Links
   Including:
   a. Developments in Suborbital Spacecraft
   b. New Events at Kennedy Space Center
   c. Pluto Flyby News and Pictures
   d. Recent Orbital Launches
   e. SpaceX and Orbital Sciences Progress
2) Discuss Business
   a. Review OSA Accounts
   b. Summary of August Meeting
3) OSA Charter
4) OSIDA Meeting Report
5) Chat

Minutes of August 8 Meeting

Oklahoma Space Alliance met at Earl's Rib Palace in Moore on August 8. In attendance were Dave Sheely, Claire and Clifford McMurray, Jim and Peggy McBride, Russ Davoren, Dennis Wigley, Tim Scott, Syd Henderson and several attendees whose names I didn't catch. OSA president Steve Swift was unable to attend due to illness. This was our Plutopalooza celebration, which included a talk by Kip McMurray, stills from the Pluto and Charon flyby, and an attempt to show the news conferences after the flyby, one of which had Clifford and Claire asking questions. We were ultimately defeated in the last by problems with the wifi connections and lack of a sound system, though we did still pass around literature and had refreshments.

At the time of the party, we still had only the first group of pictures, which were downloaded in mid-July, after which *New Horizons* began to send data rather than pictures. Additional pictures will start appearing on NASA's website beginning on September 11. I have no word on any future press conferences.

Notes on OSIDA Meeting

The Oklahoma Space Industry Development Authority met on August 12 in the Oklahoma Department of Transportation Building in Oklahoma City. Board members present were Chairman James Cunningham, Vice Chairman Robert Cox, Secretary/Treasurer Bailey J. Siegfried, and board members Jack Bonny and Alan Goodbary. Also in attendance were Air and Spaceport Executive Director Bill Khourie, Deputy Executive Director Nicola Borghini, Secretary Kim Vowell and legal advisor Kindra White. There were four in the audience, including OSA secretary Syd Henderson.

James Cunningham presented a plaque to former chair Alan Goodbary. The ATC contract involves an expenditure of $55,000.

OMES (the Office of Management and Economic Services) is taking bids to tear down the decrepit old warehouses at the Spaceport. There is also a water tower that is no longer in use that needs to be torn down,

Spirit Wind continues to conduct flight tests and will be at the Space Port another couple of months.

A replica of the Bughatti Model 100P Air Racer will begin testing this month at the Oklahoma Air and Spaceport. The original is in the Smithsonian Air and Space Museum. This test should attract a crowd of aircraft enthusiasts from Europe. See http://bugatti100p.com/ for details.

Space News: *Galileo's World*

The University of Oklahoma is having exhibits all over campus over the next year celebrating the world in the time of Galileo. Perhaps the most notable is that being held in the History of Science Collection on the fifth floor of Bizzell Memorial Library, which has three rooms of books and instruments from the 16th and 17th Centuries. Among the books are several early editions by Galileo himself, including two of his *Dialogues*, one of which, the *Dialogue on the Two Chief World Systems*, is the one that got him in trouble with the Catholic Church.

There are also books displaying the systems of the world at the time, of which there were actually three, (1) the Ptolemaic, with the Earth at the center with all other bodies revolving around in crystal spheres and epicycles, (2) the Tychonian (after Tycho Brahe) which still had the Earth at the center, but the other planets orbiting the Sun which orbited the Earth; the Moon also revolves around the Earth, and the (3), the Copernican, with the Sun at the center and the Earth and other planets revolving around it. Scientists in the Catholic regions could use the Copernican system as long as they didn't state it as factually correct, which Galileo did.

One thing I did learn about was the 16th century scientist Diego de Zuniga's "Commentary on the Book of Job," which contains the first ever explanation of the precession of the equinoxes in terms of Copernican theory. (It's really hard to explain precession if the Earth doesn't rotate.) Since this means Copernican theory is fact, he got censored just like Copernicus and Galileo. His entire work wasn't banned; they just cut out the offending commentary, which must have annotated the section where God is showing Job Arcturus and his sons and the Chambers of the South. (Or however that's translated in the Catholic Bible.)

Since this is Galileo's World, not Galileo's Life, we also get beautiful 17th Century sky maps and maps of the Earth. I love old maps like those of China (I believe transported by the Jesuits), including how Japan and Korea get misrepresented because the Chinese didn't really care that much about geography outside of China.

Among the old instruments are reproductions of Galileo's telescope, the inclined plane on which he conducted experiments in motion, an astrolabe, sextants, quadrants, compasses, bulb thermometers.

To get to the exhibit, enter the west side of Library next to the clock tower. Elevators are to the right of the Leaning Tower of Pisa.

Space News: More from Pluto

[This section would normally have been included in the August *Update*, but that was cancelled due to Steve's illness. So I get to comment more on *New Horizon* in Outreach.]

The *New Horizon* spacecraft finally arrived at Pluto on July 14 after a nine and a half year voyage. When *New Horizons* was launched on January 19, 2006, it set a record for initial launch velocity more than 36,000 miles per hour (or 10 miles per second). On its way to Pluto, it flew by asteroid 132524 APL, and got a gravity assist at Jupiter that increased its speed by 9,000 mph (although since it slowed down in the meantime, its velocity was considerably less than 45,000 mph). At the time *New Horizons* was launched, Pluto was still considered a planet by the IAU, and this would have been the final planetary flyby in the Solar System; instead, it became the second encounter with a dwarf planet, the first being *Dawn*'s encounter last March with Ceres in the asteroid belt. Since the center of mass of the Pluto-Charon system lies outside Pluto, and Charon is round, this could be considered our first view of a double dwarf planet.

Although we hadn't seen any detailed views of Pluto before the launch of *New Horizons*, we had blurry images from the Hubble Telescope that indicated that Pluto had large light and dark regions, which indicated a varied topography. We didn't really know much about Charon at all except it was round and dark. Images from both produced a lot of surprises.

First of all was a large heart-shaped region (now called Tombaugh Regio) that was bordered by a very dark region that was at first called "The Whale" and is now called Cthulhu Regio. The big surprise here is that the brighter half (Sputnik Planum) of Tombaugh Regio has very few craters and appears to be a hundred million or fewer years old. It also is covered with volatile ices, including, apparently, most of Pluto's supply of carbon monoxide. Cthulhu Regio, by contrast, has many more craters and appears to be much older—perhaps a billion years old or more. East of the "heart" but west of the tail of the whale, are six dark blotches each of which are about three hundred miles across, and there is as yet no explanation for them,

The Prime Meridian of Pluto is defined to be that facing Charon. (Pluto and Charon are tidally locked so each always presents the same face to each other.) This is directly opposite Sputnik Planum, but does pass right through the middle of Meng'Po Macula, the closest Macula to the tail of Cthulhu. Also at the zero meridian are three long markings called "Linea" named after spacecraft: Luna is the name of many Russian lunar probes, including *Luna 1*, the first spacecraft to fly by the Moon (and accidentally the first to achieve solar orbit), and *Luna 3*, the first to photograph the far side of the moon, Chandrayaan was India's first lunar probe, and Yutu, or "Jade Rabbit," was China's first lunar rover. I've no idea why the linea are clustered around the meridian of Pluto facing Charon, or why Cthulhu Regio and the Maculae follow Pluto's equator.

The north poles of both Pluto and Charon point toward Earth. This is because of a recent decision by astronomers that reversed the designation of Pluto's poles. This also makes Pluto's rotation prograde (before it was considered retrograde) and gives it an axial tilt of 120 degrees. In other words, its north pole is below the plane of its orbit. You may also see the North Pole referred to as the "positive pole," positive here being according to the right-hand rule of spinning objects. This change was considered necessary since the axes of small bodies can precess so much that the south and north poles can interchange (since the axis precesses through the orbital plane). If this definition were applied to planets, what we call the north pole of Uranus would also be called the positive pole, but it's a planet and the IAU has special rules for full planets.

The edge of Sputnik Planum facing Cthulhu Regio features three mountain ranges, Norgay Montes, Hillary Montes and Baré Montes, and a fourth Al-Idrisi Montes, faces Viking Terra. These might help explain the separation of bright Sputnik Planum and dark Cthulhu Regio since the mountain ranges would form a natural wind break. These mountains are almost certainly made of water ice: the other candidates, methane, nitrogen and carbon monoxide ices, are too soft to make mountains. Indeed, several craters at the northern edge of Sputnik Planum are partially filled by glaciers believed to be made of liquid nitrogen.

Charon has one very noticeable feature, a dark round plain at its North Pole that was immediately dubbed Mordor after Tolkein's dark land. This is now pseudo-Latinized into Mordor Macula. It's about three hundred miles across, looks like it might possibly be an impact basin or possibly a depository for hydrocarbons evaporating from Pluto. There are also a series of deep canyons, or chasma, up to three miles deep around Charon's equator, hinting at past crustal straining, perhaps produced by ancient tidal stresses. One chasm has a mountain in the middle of it. Scientists are scrambling for an explanation; Charon also has a young surface with

relatively few craters. How this is possible is unknown; it may be due to geological activity, but the source of the energy supplying this is a mystery.

We still have no good photographs of Pluto's small moons, but we'll hopefully have some from the batch of pictures expected on September 11.

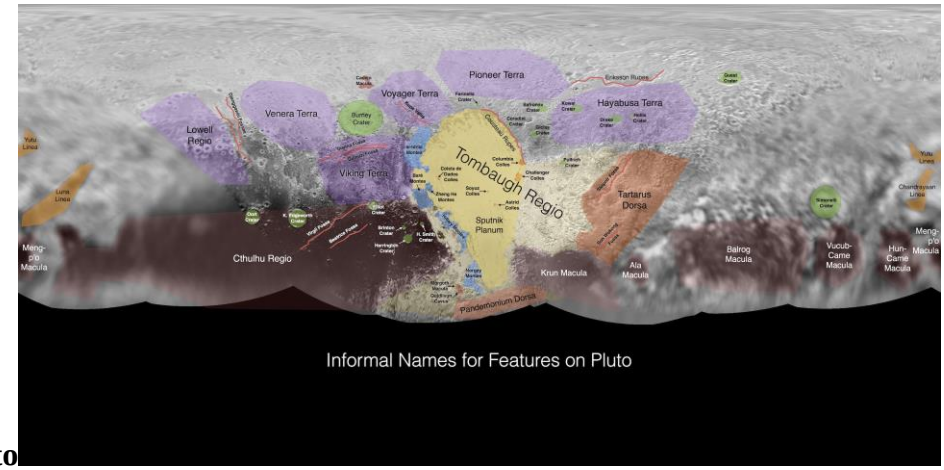
There are also good sections of Pluto and Charon that we've not seen close-up because it was in darkness when *New Horizon* passes. Some of these we did see as *New Horizons* approached Pluto, but the south (or negative) polar regions of Pluto and Charon are currently in the middle of 124 years of darkness. This is actually a good-sized region of Pluto and the only hope is that we get good photographs of the South Polar Region by Charonlight. (The spacecraft's trajectory was planned so that would happen.) Alas, there was no way to also do that for the south polar region of Charon.

With Pluto successfully encountered, NASA got to choose a second target in the Kuiper belt for *New Horizons* to visit. The chosen target is 2014 MU_{69}, which is 43.3 astronomical units away from the Sun, or about one and a half billion miles farther away than Pluto. As its name implies, this object was only discovered last year. It's only magnitude 25.6, which means it reflects considerable less than a ten-thousandth the light of Pluto. This also means that it's not just far away, but tiny. The actual size is a guess, but 30-40 miles in diameter is likely. However, it is also more likely to be representative of small Kuiper belt objects than Pluto and its moons. The encounter takes place on January 1, 2019.

Naming Pluto

With the first pictures coming in from Pluto and Charon, there were all sorts of newly discovered features awaiting names which the *New Horizons* team was prepared to provide, especially given an approved list from a NASA contest earlier this year. Note that all names must be approved by the International Astronomy Union (the same group that demoted Pluto). I'm expecting most to be approved.

Map of Pluto



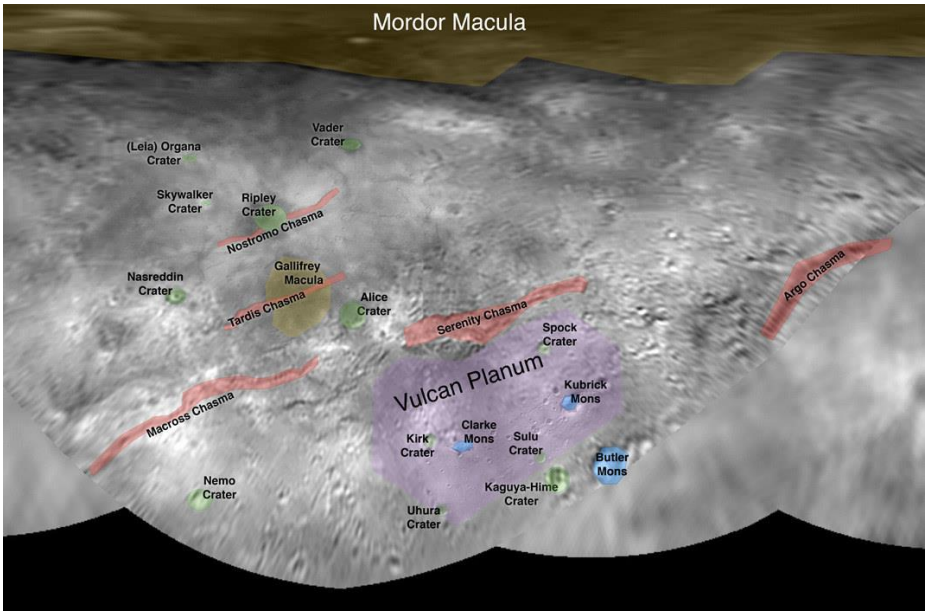
The two most prominent features on Pluto's surface are the heart-shaped Tombaugh Regio (which looks more to me like a dog's head) and the dark Cthulhu Regio, which looks like a whale or seal. Clyde Tombaugh discovered Pluto, so it's fitting the most prominent feature be named after him. Cthulhu looks a lot like a sea monster (complete with eyes) and is named for H. P. Lovecraft's amphibious Elder God. Perceval Lowell also gets a smaller Regio named for him. Powell began the search for Planet X which resulted in the discovery of Pluto. Tombaugh was working at Lowell Observatory when he discovered Pluto.

The Maculae are the "fingerholes" observed during *New Horizons*' approach to Pluto. Meng Po is the Chinese goddess who wipes the memories of souls to be reincarnated. Hun-Came and Vucuv-Came are Mayan death gods. Ala is an Igbo death god, and Krun is chief Mandaean lord of the underworld, the Mandaeans being

an ancient Gnostic offshoot of Judaism and Christiani- ty. The Balrog is famous from *Lord of the Rings*. The Maculae are collectively nicknamed the "Brass Knuckle," apparently belonging to a six-fingered person.

Numerous areas are named after spacecraft: Sputnik Planum, Venera Terra, Voyager Terra, Columbia Colles, etc. Tartarus is a region of Hades reserved for those who sinned monstrously. Virgil and Beatrice Fossae (depressions) are from Dante's guides in the *Divine Comedy*, but I don't see a Dante yet. Norgay and Hillary Montes are named for the conquerors of Mt. Everest. Baré Montes is named after Jeanne Baret aka Baré, the first woman to circumnavigate the Earth. Al-Idrisi Montes is named after a twelfth century geographer and traveler who compiled a description of the world from Japan to Greenland. The craters seem to be named for astronomers who don't already have lunar craters named after them. However, the largest crater, Burney Crater, is named after Venetia Burney, the girl whose most important contribution to astronomy is that she gave it its name. [She later taught mathematics and economics, and, under her married name, Venetia Phair, had a rock band, Venetia Fair, named after her. She died in 2009 at the age of 90, about three years after the demotion of Pluto.]

Map of Charon



The criteria for naming features on Charon are "destinations and milestones of fictional exploration, the people that explored those fictional lands, and the vessels that carried them to their mysterious destinations."

Thus Charon has acquired an sf flavor with features named for *Star Trek* (Vulcan Planum, and Kirk, Spock, Sulu and Uhuru craters), *Star Wars* (Skywalker, Organa and Vader craters), *Alien* (Nostromo Chasma, Ripley Crater), and Wonderland (Alice Crater). Macross is an anime franchise and is one of several fictional spacecraft on Charon, along with *Argo* and *Serenity* (and *Tardis* from Dr. Who, as well as his home planet Gallifrey). Nasreddin was a folklorist (I don't know his connection with space). Arthur C, Clarke and Kubrick collaborated on *2001: a Space Odyssey*; Butler Mons is named for the last SF writer Octavia Butler.

Mordor Macula, the large dark area near Charon's North Pole, is its most prominent feature and an appropriate name for a land where the shadow lies. I hope it sticks. It certainly fits the criterion of a destination of fictional exploration. (Though does this mean Frodo, Bilbo and Sam will find themselves on Charon? And what of Gollum?)

Finally, we have Kaguya-Hime Crater. Princess Kaguya comes from the ancient Japanese folktale, *The Tale of the Bamboo Cutter*, which may be over a thousand year old. Kaguya is a Moon princess who incarnates herself as a baby born in a bamboo stalk, is adopted and grows to adulthood, and finds herself overwhelmed by suitors. She may be on Pluto due to the recent animated feature, *The Tale of the Princess Kaguya*, but has been adapted to manga, other movies, television and ballet. She truly belongs on a moon, even if it's not the Moon.

Space News: Ceres Coming into Focus

The *Dawn* spacecraft is now less than 900 miles above Ceres, and we're finally getting some detailed images, including a four mile high conical mountain, startling on what looked to be a bland cratered surface (excluding the famed bright spots). *Dawn* still has a long way to descend; it will achieve final orbit, 230 miles above Ceres, around the end of October.

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 highlight this month is the **Total Lunar Eclipse** on the evening of September 27. This is a last of a series of four lunar eclipses over the last couple of years, and, unlike last April's, has a good long totality period of seventy-two minutes. This is also the biggest lunar eclipse you'll ever see, since it begins only a half hour after the Moon is at perigee.

The Moon will already be entering the Earth's penumbra when it rises in Oklahoma, but the entire total phase will be visible

8:07 p.m. Partial eclipse begins
9:11 p.m. Total eclipse begins
10:23 p.m. Total eclipse begins
11:27 p.m. Partial eclipse ends
11:55 p.m. Moon leaves penumbra

The **Orionid** meteor shower peaks the night of October 21 and 22. This is the second of two meteor showers associated with Comet Halley, the other being the Eta Aquariids in May. The Orionids are not expected to be a major shower this year, with peak only 15 meteors per hour. Radiant is in northern Orion above Betelgeuse.

Unless you want to go stargazing in the early morning this is a particularly bad month for planet viewing, with only **Mercury** and **Saturn** in the sky at sunset. We do have a very nice series of conjunctions in the morning sky starting around mid-October.

Mercury was at greatest elongation on September 4, and may still be visible 45 minutes after sunset. It's also getting dimmer as it approaches inferior conjunction on September 30. Mercury will again become visible as a morning star in mid-October, reaching greatest western elongation on the morning of October 15, and brightening through the month, reaching magnitude -0.6 on October 15 and -1 near the end of the month.

Saturn is shining about magnitude 0.5 but is also setting about three hours after the Sun. About ten degrees to its left is Antares, the bright star in Scorpius. Saturn will be setting two hours after the Sun in early October, and will start to get hard to see in late October.

Venus is magnitude -4.7 and will actually be slightly brighter at mid-month. It's currently rising a couple of hours before the Sun, but by the end of the month that will be three-and-a-half hours. Venus will only dim slightly in October,

Mars is also in the morning sky, but is still near the far end of its orbit and only magnitude 1.8. Mars is about ten degrees (the width of your fist at arm's length) to the left of Venus. On the 24th, Mars will be about a degree left of Regulus, the bright star in the Sickle of Leo. Regulus is the brighter of two. Mars will be rising about 4:30 a.m. at the beginning of October and 4:00 a.m. at the end.

Jupiter was in conjunction with the Sun on August 26 and will not be visible until mid-month, when it will rise about an hour before the Sun. By October 1, it will be rising two hours before the Sun, and four hours before the Sun at the end of October. Jupiter will be magnitude -1.8 through most of this time,

Venus, Jupiter and Mars all being in the same part of the morning sky, we are due for a series of conjunctions. On October 17, Mars will be less than a half-degree north of Jupiter, with Jupiter being three and a half magnitudes brighter. Venus will be six degrees to the west.

On October 23, Venus and Mars will be four-and-a-half degrees apart with Jupiter in-between.

On October 26, Venus will be a degree south of Jupiter, and Mars about three degrees below them.

By October 31, Venus will only be 1.4 degrees above Mars, preceding a conjunction at the beginning of November.

Uranus, which is in Pisces, is currently rising about 9:00 p.m. and is magnitude 5.7, which is just visible to the naked eye in very dark skies. It is nearing opposition, which it will reach on October 11 when it will be rising around 7:00 p.m.

Neptune, one constellation over in Aquarius, was at opposition on August 31, and is still above the horizon all night, though you'll need strong binoculars or a small telescope to see it.

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.

Pluto is 14th magnitude and in the constellation Sagittarius (as it will be until 2024), and needs a good-sized telescope to see it.

Viewing Opportunities for Satellites (September 11 to October 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. There is a Progress 61P Cargo Craft going to the ISS on October 1. The next manned launch, however, isn't until December 15. Note, though that Expedition 44 will be returning on September 11.

HST September 25, 2015

Time	Position	Elevation
8:29 p.m.	220°	20°
8:30	202	26
8:31	175	30
8:32:04	148	26
8:33:33	139	23

Vanishes into Earth's shadow

HST September 26, 2015

Time	Position	Elevation
8:20 p.m.	224°	20°
8:21	205	27
8:22	178	31
8:23	151	27
8:24	133	20

ISS September 27, 2015

Time	Position	Elevation
6:14 a.m.	315°	22°
6:15	325	41
6:16	43	74
6:17	117	41
6:18	124	22

HST September 27, 2015

Time	Position	Elevation
8:11 p.m.	227°	20°
8:12	208	27
8:13	181	31
8:14	153	27
8:15	134	20

Tiangong 1 September 28, 2015

Time	Position	Elevation
Appears from Earth's shadow		
6:25 a.m.	268°	23°
6:26	337	53
6:27	56	10

HST September 28, 2015

Time	Position	Elevation
8:02 p.m.	229°	20°
8:03	211	27
8:04	184	30
8:05	156	27
8:06	138	20

ISS October 2, 2015

Time	Position	Elevation
8:08 p.m.	191°	17°
8:09	171	27
8:10	138	35
8:11	94	28
Vanishes into Earth's shadow		

ISS October 4, 2015

Time	Position	Elevation
8:00 p.m.	234°	21°
8:01	240	40
8:02	311	77
8:03	36	42
8:04	43	22

Tiangong 1 October 6, 2015

Time	Position	Elevation
Appears from Earth's shadow		
6:34 a.m.	308°	15°
6:36	22	51
6:36	101	10
Passes very close to Jupiter and Mars and about ten degrees from Venus		

Tiangong 1 October 8, 2015

Time	Position	Elevation
Appears from Earth's shadow		
6:05:10 a.m.	320°	69°
6:05:27	25	81
6:08	115	10

We have an unusual sequence of evening viewing opportunities of the Hubble Space Telescope in late September. I have to warn you, though, that twilight will be infringing a bit on the last couple.

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 8:01 p.m. on October 4, measure three fist-widths south from due west, then four 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 11, 12:30 p.m.: ISS Expedition 44 Farewells and hatch closure coverage. (Hatch closure is at 12:45 p.m.) 4:00 p.m.: Undocking coverage. (Undocking is 4:27 p.m.) 6:30 p.m.: Coverage of deorbit burn and reentry. (Deorbit burn, 6:58 p.m.; landing 7:51 p.m.)

September 13: 8:00 a.m. ISS One-Year Crew Update, including an interview with Mission Commander Scott Kelly.

(Note: Sometime in mid-September we should start getting more news briefings from the *New Horizons* staff. New unprocessed pictures will start getting posted at http://pluto.jhuapl.edu/soc/Pluto-Encounter/index.php on September 11.

Calendar of Events

September 12: Oklahoma Space Alliance meeting, 2:00 p.m., Harry Bear's All-American Grill.

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 4: 58th anniversary of launch of *Sputnik 1*, the first spacecraft to orbit the Earth.

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 Bennu 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)

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

OSA E-mail Addresses and Web Site:

sswift42 at aol.com (Steve Swift)
cliffclaire at hotmail.com (Claire McMurray)
sydh at ou.edu (Syd Henderson)
ctscott at mac.com (Tim Scott)
t_koszoru01 at cox.net (Heidi and Tom Koszoru, new address)
sheely at sbcglobal.net or david.sheely.1 at us.af.mil (David Sheely)
john.d.northcutt1 at tds.net (John Northcutt)
lensman13 at aol.com (Steve Galpin)

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

Other Information

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

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

Tulsa Air and Space Museum, 7130 E. Apache, Tulsa, OK 74115.
Web Site is www.tulsaairandspacemuseum.com. Phone (918) 834-9900.

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

The National Space Society's Headquarters phone is 202-429-1600. Executive Director e-mailnsshq@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.)
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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.

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