OUTREACH March 2014

March Meeting:

Oklahoma Space Alliance will meet at 3:30 on Saturday, March 8, 2014, at Harry Bears All-American Grill, 2113 Riverwalk Dr., Moore, Oklahoma, (2 tenths of Mile South of S. 19th And West of I35 Frontage Road). The number is 405-799-2327

March 8, 2014
Meeting Agenda

Place: Harry Bears in Moore, OK

3:30 PM

1) Business Meeting
    a. Review Minutes and Agenda
    b. New mail
    c. Treasurers Report
    d. Report on OSIDA
    e. Old Business
        i. Yuri's Night
        Stafford Air and Space Museum has agreed to a Joint Yuri's night
        ii. Art Contest
    f. New Business

4:30

2) What's Happening
    Let's see and discuss articles, slides and videos of current Space and Space Industry news including launches, technology, developments, people and art.
3) Special Feature: Launch vehicle comparisons
4) Adjourn

Minutes of February Meeting

Oklahoma Space Alliance met at Harry Bear's All-American Grill in Moore on February 8, 2014. In attendance were Steve, Karen and Brian Swift, Vickey Richartz, Russ Davoren, Dave Sheely, Dennis Wigley, Claire and Kip McMurray, Tim Scott and Syd Henderson.

We now have $872.85 in the checking account and $257 in cash.

Yuri's Night: Russ has talked to Weatherford. He and Steve will travel to there and to the Science Museum Oklahoma in Oklahoma City. The Sam Noble Oklahoma Museum of Natural History can handle around 50 people, and have three rooms we can rent. They have catering services. Do we want to have a meal or just munchies? We need cost of rooms.

Steve will make a decision before the next meeting. OSA voted to give him the authority to do so.

Art Contest: Claire has made some calls and has contacts within the Norman School System.

Annual Report: Tim is ready with finances and membership. Syd is doing activity report and will send it to Steve and Tim. Tim wants it as a pdf attachment.

Candidate subjects for Oklahoma Space Alliance: Anybody who has a subject can send it to Steve.

What's Happening in Space?

"There are too many accidents that can befall life on a single planet. But I'm an optimist. We will reach out to the stars." --Steven Hawking, Daily Telegraph interview 2001

Presentations this month: (Links to the articles and videos can be found on our website in Steve's web version of What's Happening http://chapters.nss.org/ok/1402%20Whats%20Happening.pdf, so I won't duplicate all of them here.)

NASA launched a TDRS-L (Tracking and Data Relay Satellite). This one relays signals between the Space Station and ground control, ensuring almost continual communication. United Launch Alliance does good videos, and we watched a launch video.

SpaceShipTwo's third powered flight took it to 71,000 feet (14 miles). There's been some speculation in the industry as to why Virgin Galactic has made only three tests flights of SpaceShipTwo, none of them into space.

Virgin Galactic tested its Launcher One engines, which are for a rocket designed to be launched from WhiteKnightTwo.

The Solar Wind Produces Water in Interplanetary dust. The solar wind contains protons that bombard silicates in space, knocking loose oxygen atoms that combine with the protons to make water.

Arianespace had its 58th consecutive successful Ariane 5 launch. We watched video of it launching though rain.

Among the cargo onboard the Cygnus launch to the Space Station last January were eight ant farms.

Carbon Dioxide is Not Just a Greenhouse Gas. It can also be used in making nanomaterials.

A Dutch project shows that plants are able to grow in Martian-like soil.

Elon Musk did an interview with the *Business Insider* that's up on line.

Space News: This is mostly links on our web page.

The US House of Representatives passed $696 million in funding for the Commercial Crew Program.

Bigelow needs clarification of Luna Property Rights. [Bigelow wants ownership of resources mined in space and to bar other companies from interfering with its operations. The Outer Space Treaty bans the ownership of, say, Mare Imbrium. "Customary international law already recognizes that extraterrestrial materials brought back to Earth can be owned and sold — just like the thousands of space meteorites available today on eBay. The U.S. and Soviet Union both claimed ownership in lunar resources extracted and returned to Earth, and exchanged samples without international objection. (The 1979 Moon Agreement would have banned appropriation of extraterrestrial materials in space but has been ratified by only a handful of countries, and was firmly rejected by the U.S. Senate.)" So Bigelow would own material it picked up on Mare Imbrium without actually owning the lunar sea. This lunar property rights article deserves a TinyURL **http://tinyurl.com/mmqc8x2** --Syd]

Planetary Resources is crowd-funding a space telescope to look for likely asteroids.

This year's International Space Development Conference is May 14 – 18 in Los Angeles. Claire says the people who will be there to receive awards are people we would really like to see. [For more on this, see "Space News" below.]

--Notes by OSA Secretary Syd Henderson

Notes on OSIDA Meeting

The Board of Directors of the Oklahoma Space Industry Development Authority met on February 12, 2014 at the Oklahoma Air and Space Port in Burns Flat, Oklahoma. The event presented OSIDA's new Control Center and offices. At heart and center of the new building is a large control room designed with six locations for client control stations. The station requirements were designed by the facilities director of Vandenberg AFB Space Launch Complex. Each control station has standardized power, network, dish and communications hook-ups. Large displays are planned for the walls. Space Port users will supply their own operational equipment for the workstations. The raised floor control room is supported by battery backup. The building includes the air and spaceport offices and meeting rooms.

Items discussed by the Board include the following:

1) A one-year extension of the Joint use Agreement with the Air Force is planned.
2) The Oklahoma House of Representatives review of OSIDA's budget went very well. Senate review and approval is expected.
3) Engineering plans for airport runway projects are complete. These include runway joint sealing, an internally lit wind sack and 5400 feet of new electric cable for runway lighting.
4) Board approved plans for Building plaque and Sign.
5) Bill Khourie hopes to use Commerce Department contractor to implement new web site.

--Notes by OSA President Steve Swift

Update on Yuri's Night

Russ Davoren, Steve Swift and Claire McMurray visited the Stafford Air and Space Museum in Weatherford Oklahoma. They met with Museum Director Max Ary, Marketing Specialist Brandi Rizzi and others. Max agreed on a joint event to include Yuri's night and Apollo 13.

The agreement includes:

1) Event will be on April 12 at 7:00 p.m. OSA to arrive at 6:30 p.m.
2) NSS Banner will be displayed
3) OSA Banner also, if one is available
4) OSA provided Yuri's Night slides to be included
5) Museum will be open for attendees
6) Introduction will include short comments on Yuri's Night
7) Max will add comments on Apollo 13
8) Apollo 13 Movie
9) Snacks – OSA contribution $100
10) A discounted fee of $5 per person required by museum
11) Museum will provide each OSA participant with Museum passes for future visit.

OSA will most likely have bus transportation for the event.

A *Cosmos* Reborn

Many of us fondly remember Carl Sagan's 1980 science series *Cosmos: A Personal Voyage*. Neil de Grasse Tyson's sequel *Cosmos: A Space-Time Odyssey* will premiere simultaneously at 8:00 p.m. on Sunday, March 9 on ten channels owned by Fox. Subsequent episodes will be shown

on Fox and the National Geographic Channel (12 and 72 on Cox Cable), with episodes being repeated quite often on the latter. It looks like it will cover a lot more than space. Episode 2, "Some of the Things that Molecules Do" is about natural selection, evolution and extinction, and Episode 9, "The Electric Boy" is about Michael Faraday and the birth of the electrified world.

Like the original series, *Cosmos: A Space-Time Odyssey* will consist of 13 hour-length episodes. (Actually 42-minute episodes due to all the commercials. I trust it will also be streamed on Huluplus.) The April issue of *Sky & Telescope* has an overview of the series, together with brief descriptions of the subject matter of each episode.

Space News

Supernova 2014J peaked at magnitude 10.5 in early February and has now faded to magnitude 11. That may not sound like much, but it is located eleven million light-years away, tying it for the closest supernova since the famous naked-eye Supernova 1987A in the Large Magellanic Cloud. This one in is galaxy M82 in Ursa Major, meaning it is visible through telescopes all night long. The actual explosion is believed to have begun for us around midnight on the night of January 14 – 15, but the supernova wasn't discovered for a week later, which is remarkable considering M82 is a pretty well-known galaxy.

On February 25, scientists analyzing data from the Kepler Space Telescope announced that they have confirmed the existence of 715 more exoplanets, nearly doubling the number of confirmed planets. All of these exoplanets are in multi-planet systems (presumably they were confirmed by their gravitational effects on other planets), and 95% of them are the size of Neptune or smaller, with some of them about the size of Earth. This indicates that (as expected) small planets are much more common than Jupiter and Saturn sized planets.

One problem that bedevils scientists trying to discover exoplanets by the transit method is that an eclipsing binary star system can mimic a planet orbiting a star (especially since brown dwarfs have the diameter of Jupiter). This is very unlikely, though, if there are more than one planetary candidate orbiting a star, because a system with three stars close together is gravitationally unstable. Actually a system with two stars and a planet close together would probably be unstable. A system with one star and a bunch of planets, on the other hand, can be very stable, and we live in one such. The confidence level that these exoplanets exist is around 99%.

Four of the planets have less than 2.5 times the diameter of the Earth and lie in their star's habitable zone. Given the unlikelihood of discovering such a planet in the first place, they must very common.

All these 715 planets come from the first two years of Kepler's data, so there will be many more to come. Kepler requires three transits to confirm a planet, which means it would require three years to confirm the existence of another Earth.

From the NSS website:

"The National Space Society takes great pleasure in awarding its 2014 Space Pioneer Award for the Science and Engineering category to the (Mercury) MESSENGER Team. MESSENGER stands for MErcury Surface, Space ENvironment, GEochemistry, and Ranging. This spacecraft entered an orbit around the planet Mercury and conducted an extensive scientific survey of the entire planet, the first human object to do so. With this award, NSS recognizes both the importance of the first dedicated probe to orbit Mercury and the significance of the scientific results already released.

The National Space Society will present the Space Pioneer Award to MESSENGER project representatives Drs. Sean C. Solomon, Larry R. Nittler and Ralph McNutt at NSS's annual

conference, the 2014 International Space Development Conference (ISDC). The conference will be held at the Sheraton Gateway Hotel in Los Angeles, CA. The ISDC will run from May 14-18, 2014."

The movie *Gravity*, starring Sandra Bullock as an astronaut stranded alone in space, won seven of its ten Academy award nominations, including best director, cinematography, and editing. It lost Best Picture, making it second all-time among multiple Oscar winners to lose Best Picture (*Cabaret* holds the record with eight.)

Geochemists have traced the condensation of solid matter to 4.567 billion years ago [on a Tuesday], but no rocks on Earth date that far back, presumably because its surface was molten. However, a zircon in Australia has been shown to be 4.374 billion years old, which means it took less than 190 million years from the Earth's formation and the beginnings of the formation of solid crust.

If the theory that the Moon was formed by a planet-sized object colliding with the Earth is correct, the solidifying of the Earth's crust must have taken place pretty quickly on the cosmic time scale.

The Air Force has formally certified the Falcon 9 v1.1's first flight last September despite the failure of the upper stage to reignite after releasing its payload. SpaceX has to perform three of these flights successfully. The second was the launch of a SES-8 telecommunications satellite on December 3, and the third was the Thaicom-6 launch on January 6. These have not been certified yet, but since those launches had no problems, there should be no difficulty getting certification. Once all three flights have been certified, SpaceX can bid on national security launch contracts. [Space.com, March 3, 2014.]

Construction is now ready to begin on the Giant Magellan Telescope in the Chilean Andes. This telescope will have a diameter almost a thousand inches across, which means it will have six times the light-gathering area of today's largest telescope and ten times the resolution of the Hubble Space Telescope. The telescope's seven primary mirrors will each be 330 inches across. Construction of the observatory will require levelling a mountaintop. Three of the seven mirrors are already being produced, the fourth will be produced in 2015 and the GMT will begin operations in 2020.

Sky Viewing

There will be a **total eclipse of the Moon** visible from North America on the night of April 14 -15. The eclipse will begin with the penumbral phases 11:54 p.m., with the partial phase beginning at 12:58 a.m., totality beginning at 2:07 a.m. and ending at 3:25 a.m., partiality ending at 4:33 a.m. and penumbral phase at 5:38 a.m. (all times CDT). This eclipse will be visible in its entirety from Oklahoma.

There will be a second total eclipse of the Moon on October 8, but that one will be mostly be taking place late in the afternoon.

There is also an **annular Solar** eclipse on April 29, but the annular phase is only visible from the part of Antarctica that is near the Indian Ocean and perhaps the eastern tip of Australia.

Mercury is low in the eastern sky right before dawn. It's currently about magnitude 0.3. Mercury will be at greatest elongation on March 13, but this isn't a particularly good one, and after March 18, it will probably be impossible to view it at all without binoculars. Although

Although Mercury will brighten after greatest elongation, it will also be low in the sky and is heading toward superior conjunction near the end of April.

Venus is currently near maximum brightness (-4.8) and dominates the morning sky. It will be at greatest elongation on March 22, but is brightest before that: its closeness to Earth makes up for less of its surface being lit. However, like Mercury, Venus is relatively low in the sky (this is due to the angle of the ecliptic), and in April will only be ten degrees above the horizon an hour before sunrise.

Mars is magnitude -0.5 and still brightening as it approaches opposition on April 8, at which point it will be magnitude -1.5. Mars is currently in Virgo and moving retrograde against the stars, so it will stay in Virgo through the end of April. This opposition, Mars will appear 15 arcseconds wide, which is better than the last several oppositions, but much smaller than the 24 arcseconds wide it will appear in 2018.

Jupiter is currently high in the southeastern sky at sunset and, at magnitude -2.4, is the brightest object in the evening sky other than the Moon. Jupiter is currently in the constellation Gemini, where it will remain through the month of April.

Saturn is magnitude 0.5 and brightening as it approaches a May 10 opposition. By the end of April, it will be shining at magnitude 0.1. Saturn is currently in the constellation Libra, one constellation over from Mars and rising about 11:40 p.m. By April 7, it will be rising at 9:30 p.m., and at the end of April, it will be rising at sunset and stay at the sky all night long.

Uranus is in conjunction with the Sun on April 2 and will not be visible in March and April. **Neptune** was in conjunction with the Sun on February 23, and is not currently visible even with binoculars; however, on April 12, Neptune will be 0.7 degrees south of Venus and you may be able to find it just before morning twilight.

The asteroid **Vesta** will be in opposition on April 13, and the dwarf planet/asteroid **Ceres** on April 15. As you might expect, this means they are close in the sky, and, indeed, they are both in the constellation Virgo not far from Mars. Vesta will be magnitude 5.8 and Ceres 7.0. Although Ceres is larger than Vesta, Vesta is closer to Earth and has a much more reflective surface, so appears brighter. The two asteroids are approaching a conjunction on July 15, when they will be only 10 arcminutes apart. (By comparison, the Moon's disk is about 30 arcminutes in diameter.) They will, however, be more than a magnitude dimmer.

There is a finder map for Ceres and Vesta online at media.skyandtelescope.com/documents/Web_Ceres_Vesta_2014.pdf

The asteroid **Pallas** will be passing into Leo in April, moving toward Regulus, and will be slightly brighter than Neptune for a couple of weeks. There's a finder chart on page 43 of the April *Sky & Telescope*.

[Data for this section from *Astronomy*, *Sky & Telescope*, Wikipedia and NASA.]

Viewing Opportunities for Satellites (March 8 – April 9, 2014)

You can get sighting information at www.heavens-above.com/. Heavens Above allows you to get satellite-viewing data for 10-day periods, and gives you a constellation map showing the trajectory of the satellite. Heavens Above has changed its detail view so that you can no longer get location coordinates. On the other hand, it does give very useful maps.

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. (Note: I'm having problems accessing this from my home PC, but not from the Mac at work.) 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 Space Station may change its orbit. SpaceX will be launching a Dragon capsule to the Space Station on March 16, and Expedition 39 will be launched to the Space Station on March 25.

Tiangong-1 March 7, 2014

Time	Position	Elevation
6:21 a.m.	238°	10°
6:24	152	77
6:27	66	10

Tiangong-1 March 9, 2014

Time	Position	Elevation
Appears from Earth's Shadow		
6:54:56 a.m.	259°	22°
6:55:44	335	63
6:59	58	10

Station March 11, 2014

Time	Position	Elevation
6:16 a.m.	218°	27°
6:17	212	41
6:18	138	75
6:19	61	42
6:20	53	22

Station March 14, 2014

Time	Position	Elevation
Appears from Earth's Shadow		
5:24:45 a.m.	251°	40°
5:26	310	67
5:27	27	40
5:28	38	22

Tiangong-1 March 20, 2014

Time	Position	Elevation
Appears from Earth's shadow		
6:37:05 a.m.	306°	43°
6:39:24	26	74
6:42	112	10

Tiangong-1 March 28, 2014

Time	Position	Elevation
8:59 p.m.	226°	10°
9:02:15	149	50
9:02:45	112	45
Vanishes into Earth's Shadow		

Tiangong-1 March 30, 2014

Time	Position	Elevation
8:27 p.m.	240°	10°
8:30	152	83
8:33	64	10

Station March 31, 2014

Time	Position	Elevation
5:43 a.m.	321°	21°
5:44	332	41
5:45	43	68
5:46	110	40
5:47	120	21

HST March 31, 2014

Time	Position	Elevation
5:44 a.m.	219°	20°
5:45	201	27
5:46	175	30
5:47	145	26
Vanishes in Earth's Shadow		

The Hubble Space Telescope also makes appearances beginning at 5:38 on April 1, 5:31 on April 2, and 5:25 on April 3. The paths are similar to that of March 31, complete with vanishing.

Station April 3, 2014

Time	Position	Elevation
Appears from Earth's Shadow		
4:48 a.m.	306°	43°
4:49	210	83
4:50	137	42
4:51	136	22

Station April 5, 2014

Time	Position	Elevation
7:43 p.m.	192°	18°
7:44	173	29
7:45	133	37
7:46	92	29
7:47	73	18

Station April 6, 2014

Time	Position	Elevation
8:28 p.m.	266°	17°
8:29	285	27
8:30	325	34
8:31	2	27
8:32	21	17

Tiangong-1 April 9, 2014

Time	Position	Elevation
8:51 p.m.	302°	10°
8:54:08	24	62
8:55:51	101	22

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 find the Hubble Space Telescope at 5:46 a.m. on March 31, measure half the width of your fist east from due south, then three 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:

March 9, 5:00 a.m.: Change of command ceremony on the ISS

March 10, 6:45 a.m.: Undocking coverage for ISS Expedition 38. (Undocking is 7:02 a.m.) 9:15 a.m.: Reentry and landing for ISS Expedition 38. (Deorbit begins at 9:30 and landing at 10:24.)

March 16, 2:45 a.m.: Launch coverage of SpaceX/Dragon mission to the ISS. (Launch is at 3:31 a.m.)

March 18: 4:45 a.m.: Coverage of Rendezvous of Dragon Capsule. (Grapple at 6:00 a.m.) 9:00 a.m.: Coverage of berthing, (Berthing begins at 9:30 a.m.)

March 25: 3:15 a.m.: Launch coverage of Expedition 39/40 to the ISS. (Launch is at 4:17 a.m.) 9:30 p.m.: Docking coverage (Docking at 10:04 p.m.). 11:30 p.m.: Hatch opening coverage (Hatch opening is at midnight.)

Space-Related Articles

"A New Renewable Energy Source? Device Captures Energy from Earth's Infrared Emissions to Outer Space," from *Science Daily*, from an article from the Harvard School of Engineering and Applied Science. Link: www.sciencedaily.com/releases/2014/03/140303154015.htm

In this case they're hoping to use the energy gradient between the night sky and the surface of the Earth. The surface of the Earth cools at night by emitting infrared radiation, which is a possible energy source. The idea is that if you have a microscopic antenna that is emitting infrared radiation from one end, that end of the antenna cools off, producing a temperature differential that can be exploited. So you need to produce a lot of such antennas in a small space, which means nanotechnology.

I think this is still many years away, like fusion power, but it's interesting that there is a possibility of producing energy on Earth by sending radiation into space rather than absorbing it on Earth. (Although, in this case, as in so many others, the energy originally comes from the Sun.)

On a related note, here is how to make ice cream in the desert, not to mention a refrigerator that doesn't rely on electricity:
http://blog.stickyrice.net/archives/2008/ice-in-the-desert-a-fridge-without-electricity/

Calendar of Events

March 8: Oklahoma Space Alliance meeting, location to be announced.

March 12: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

March 13: Mercury is at greatest western elongation, 27 degrees from the Sun (so can be seen before sunrise).

March 26: Expedition 39/40 is launched to the Space Station.

March 27: Venus is at greatest western elongation, 47 degrees from the Sun (so can be seen before sunrise).

April 2: Uranus is in conjunction with the Sun.

April 6: Space-X's fourth resupply flight to the ISS.

April 8: Mars is at opposition.

April 9: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

April 12: Yuri's night. 53rd anniversary of manned space flight.

April 12: Oklahoma Space Alliance Yuri's Night Celebration, details to be announced.

April 13: The asteroid Vesta is at opposition.

April 14-15, 2014. Total eclipse of the Moon visible from North America.

April 15: The dwarf planet Ceres is at opposition.

April 25: Mercury is in superior conjunction with the Sun.

May 1: Orbital Services second Antares launch to the ISS.

May 10: Saturn is at opposition.

May 10: Oklahoma Space Alliance meeting, location to be announced.

May 14: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

May 24: May Camelopardalids. This is a new meteor shower, and may turn out to be the best of the year.

May 25: Mercury is at greatest eastern elongation, 23 degrees from the Sun (so can be seen after sunset).

May 28: Expedition 40/41 is launched to the Space Station.

June 6: SpaceX resupply mission to the Space Station.

June 11: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

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

June 19: Mercury is in inferior conjunction with the Sun.

July 2014: Launch date of *Hayabusa 2* sample return mission to asteroid 1999 JU_3. Web site is www.jspec.jaxa.jp/e/activity/hayabusa2.html.

July 4: Pluto is at opposition.

July 9: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

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

July 12: Mercury is at greatest western elongation, 21 degrees from the Sun (so can be seen before sunrise).

July 20: 45th Anniversary of first moon walk.

July 24: Jupiter is in conjunction with the Sun.

August 8: Mercury is in superior conjunction with the Sun.

August 9: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

August 13: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

August 12: Peak of Perseid Meteor Shower,

August 2014 - December 2015: The European Space Agency's *Rosetta* space probe orbits comet Churyumov-Gerasimenko. In November 2014, it will release the Philae lander. Web page is www.esa.int/SPECIALS/Rosetta or visit en.wikipedia.org/wiki/Rosetta_%28spacecraft%29.

August 29: Neptune is at opposition.

September 10: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

September 12: SpaceX resupply mission to the ISS.

September 13: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

September 21: Mercury is at greatest eastern elongation, 26 degrees from the Sun (so can be seen after sunset).

September 22: *MAVEN* arrives at Mars.

September 24: *Mangalyaan* arrives at Mars.

September 30: Expedition 41 launched to the ISS.

October 7: Uranus is at opposition.

October 8: Total eclipse of the Moon visible from almost all of the Pacific Ocean, eastern Australia and western North and South America.

October 11: [Tentative] Oklahoma Space Alliance meeting, location to be announced.

October 15: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

October 16: Mercury is in inferior conjunction with the Sun.

October 19: Comet Siding Spring will pass within 65,000 miles of Mars. There is a 0.01% probability of an actual collision.

October 25: Venus in superior conjunction with the Sun.

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

November 12: [Tentative.] Oklahoma Space Industry Development Authority Meeting at 1:30 p.m., Oklahoma Department of Transportation Building in Oklahoma City.

November 18: Saturn is in conjunction with the Sun.

November 21: Mercury is at greatest western elongation, 19 degrees from the Sun (so can be seen before sunrise).

December 1: Expedition 42 launched to the space station.

December 5: SpaceX resupply mission to the ISS.

December 8: Mercury is in superior conjunction with the Sun.

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

Sometime in 2015: China launches the Tiangong-2 and 3 space stations. Tiangong-3 will eventually become the core of a large Chinese space station in the 2020s.

Sometime in 2015: Launch of Japan's *Astro-H* X-ray astronomy spacecraft. For details, visit http://astro-h.isas.jaxa.jp/index.html.en.

February 2015: *Dawn* space probe arrives at Ceres. Operations are scheduled to continue through July. *Dawn* may continue on to other asteroids if it is still operational.

June 6, 2015: Venus is at greatest eastern elongation, 45 degrees from the Sun (so can be seen after sunset).

July 2015: The European Space Agency launches *LISA Pathfinder*. LISA=Laser Interferometer Space Antenna, a gravitational wave detector that is a joint ESA/NASA project. Web site is http://sci.esa.int/lisapf.

July 14, 2015: The *New Horizons* probe passes through the Pluto-Charon system. The New Horizons web site is pluto.jhuapl.edu/.

August 15, 2015: The European Space Agency/JAXA BepiColombo Mercury Orbiter is launched. Home page is http://sci.esa.int/bepicolombo.

August 15, 2015: Venus is in inferior conjunction with the Sun.

October 26, 2015: Venus is at greatest western elongation, 46 degrees from the Sun (so can be seen before sunrise).

Sometime in 2016: 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. [Moved from 2015 after being moved from 2014.]

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.

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/.

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

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

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

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

January 2017: Proposed launch date for 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.

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).

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

Sometime in 2018: Russia launches the orbiter of the "Luna-Glob" mission. [See 2016 for the lander launch.]

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.)

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 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.

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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. Web site www.state.ok.us/~okspaceport.

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, rutledg-es@chapters.nss.org. The address is: National Space Society, 1155 15th Street NW, Suite 500, Washington DC 20005 Web page is www.nss.org.

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

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

Congressional Switchboard 202/224-3121.

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

OKLAHOMA SPACE ALLIANCE
A Chapter of the National Space Society

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Please enroll me as a member of Oklahoma Space Alliance. Enclosed is:
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National Space Society has a special $30 introductory rate for new members ($35 for new international members). Regular membership rates are $55, international $65. Student memberships are $25. 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.

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