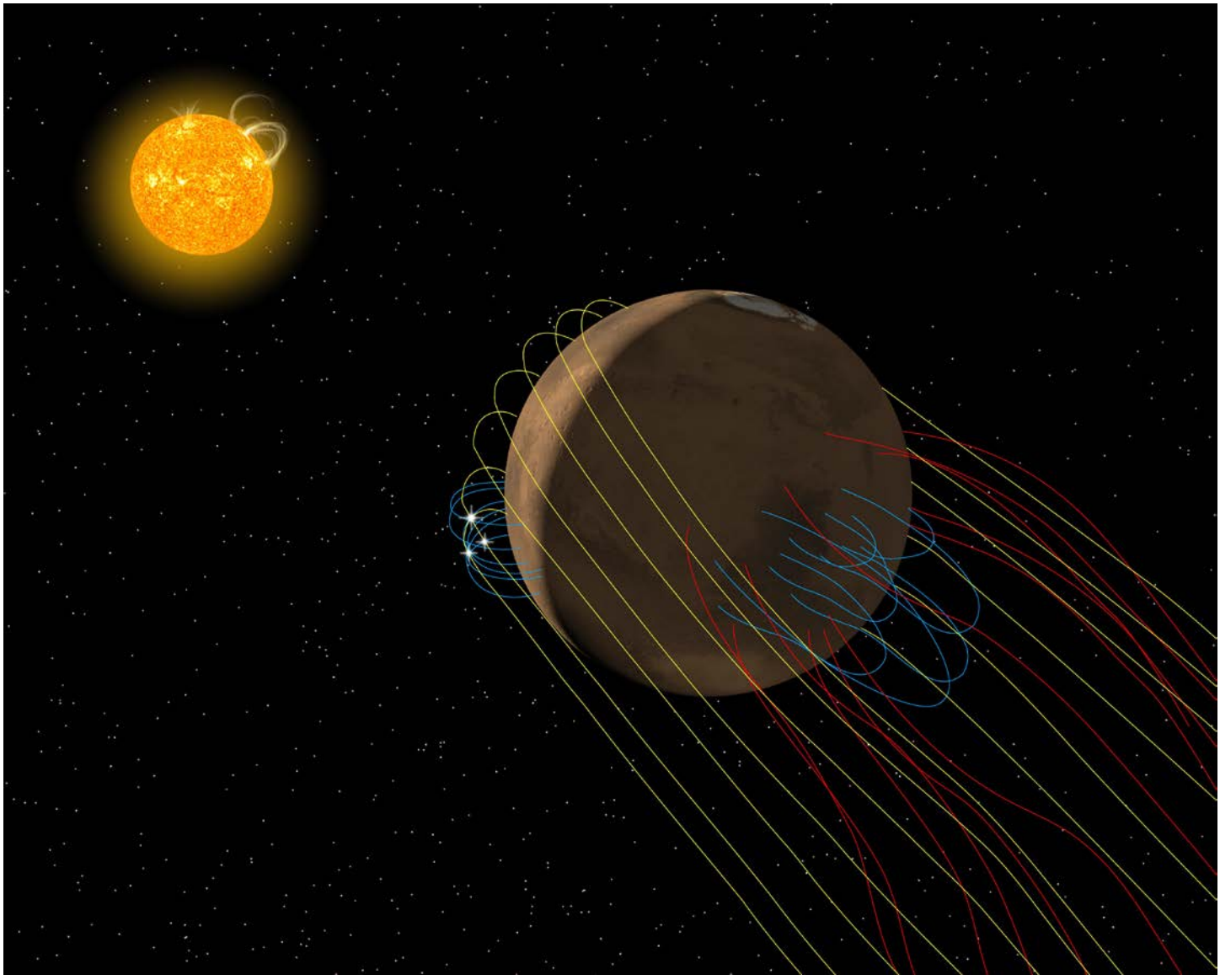
# Space News Update

## — October 20, 2017 —

## Contents

## 1. NASA’s MAVEN Mission Finds Mars Has a Twisted Tail



Mars has an invisible magnetic “tail” that is twisted by interaction with the solar wind, according to new research using data from NASA’s MAVEN spacecraft.

NASA’s Mars Atmosphere and Volatile Evolution Mission (MAVEN) spacecraft is in orbit around Mars gathering data on how the Red Planet lost much of its atmosphere and water, transforming from a world that could have supported life billions of years ago into a cold and inhospitable place today. The process that creates the twisted tail could also allow some of Mars’ already thin atmosphere to escape to space, according to the research team.

“We found that Mars’ magnetic tail, or magnetotail, is unique in the solar system,” said Gina DiBraccio of NASA’s Goddard Space Flight Center in Greenbelt, Maryland. “It’s not like the magnetotail found at Venus, a planet with no magnetic field of its own, nor is it like Earth’s, which is surrounded by its own internally generated magnetic field. Instead, it is a hybrid between the two.” DiBraccio is project scientist for MAVEN and is presenting this research at a press briefingThursday, Oct. 19 at 12:15pm MDT during the 49th annual meeting of the American Astronomical Society’s Division for Planetary Sciences in Provo, Utah.

The team found that a process called “magnetic reconnection” must have a big role in creating the Martian magnetotail because, if reconnection were occurring, it would put the twist in the tail.

“Our model predicted that magnetic reconnection will cause the Martian magnetotail to twist 45 degrees from what’s expected based on the direction of the magnetic field carried by the solar wind,” said DiBraccio. “When we compared those predictions to MAVEN data on the directions of the Martian and solar wind magnetic fields, they were in very good agreement.”

Mars lost its global magnetic field billions of years ago and now just has remnant “fossil” magnetic fields embedded in certain regions of its surface. According to the new work, Mars’ magnetotail is formed when magnetic fields carried by the solar wind join with the magnetic fields embedded in the Martian surface in a process called magnetic reconnection. The solar wind is a stream of electrically conducting gas continuously blowing from the Sun’s surface into space at about one million miles (1.6 million kilometers) per hour. It carries magnetic fields from the Sun with it. If the solar wind field happens to be oriented in the opposite direction to a field in the Martian surface, the two fields join together in magnetic reconnection.

The magnetic reconnection process also might propel some of Mars’ atmosphere into space. Mars’ upper atmosphere has electrically charged particles (ions). Ions respond to electric and magnetic forces and flow along magnetic field lines. Since the Martian magnetotail is formed by linking surface magnetic fields to solar wind fields, ions in the Martian upper atmosphere have a pathway to space if they flow down the magnetotail. Like a stretched rubber band suddenly snapping to a new shape, magnetic reconnection also releases energy, which could actively propel ions in the Martian atmosphere down the magnetotail into space.

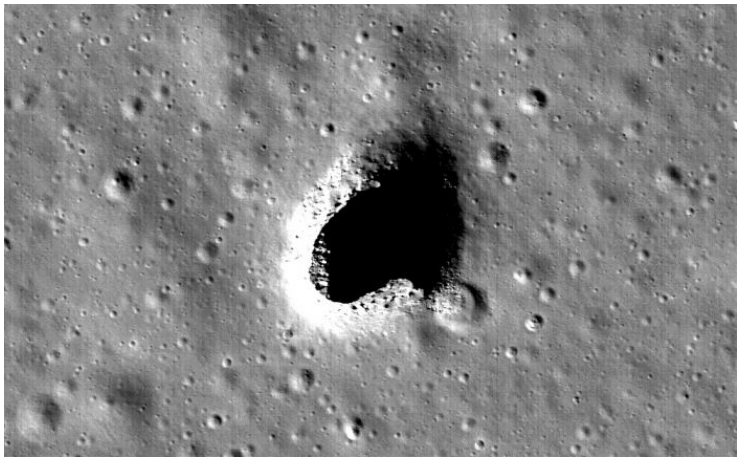
Since Mars has a patchwork of surface magnetic fields, scientists had suspected that the Martian magnetotail would be a complex hybrid between that of a planet with no magnetic field at all and that found behind a planet with a global magnetic field. Extensive MAVEN data on the Martian magnetic field allowed the team to be the first to confirm this. MAVEN’s orbit continually changes its orientation with respect to the Sun, allowing measurements to be made covering all of the regions surrounding Mars and building up a map of the magnetotail and its interaction with the solar wind.

Magnetic fields are invisible but their direction and strength can be measured by the magnetometer instrument on MAVEN, which the team used to make the observations. They plan to examine data from other instruments on MAVEN to see if escaping particles map to the same regions where they see reconnected magnetic fields to confirm that reconnection is contributing to Martian atmospheric loss and determine how significant it is. They also will gather more magnetometer data over the next few years to see how the various surface magnetic fields affect the tail as Mars rotates. This rotation, coupled with an ever-changing solar wind magnetic field, creates an extremely dynamic Martian magnetotail. “Mars is really complicated but really interesting at the same time,” said DiBraccio.

The research was funded by the MAVEN mission. MAVEN began its primary science mission on November 2014, and is the first spacecraft dedicated to understanding Mars’ upper atmosphere.

Source: NASA Return to Contents

## 2. Stable Lava Tube Provide a Potential Human Habitat on the Moon



On October 5th, 2017, Vice President Mike Pence announced the Trump administration's plan to return astronauts to the Moon. Looking to the long-term, NASA and several other space agencies are also intent on establishing a permanent lunar base there. This base will not only provide opportunities for lunar science, but will facilitate missions to Mars and beyond.

The only question is, where should such a base be built? For many years, NASA, the ESA and other agencies have been exploring the possibility of stable lava tubes as a potential site. According to new study by a team of international scientists, the presence of such a tube has now been confirmed in the Marius Hills region. This location is likely to be the site of future lunar missions, and could even be the site of a future lunar habitat.

In 2009, data provided by the Terrain Camera aboard JAXA's *SELENE* spacecraft indicated the presence of three huge pits on the Moon. These pits (aka. "skylights") were of particular interest since they were seen as possible openings to subsurface lava channels. Since then, the Marius Hills region (where they were found) has been a focal point for astronomers and planetary scientists hoping to confirm the existence of lava tubes.

The recent study, titled "Detection of intact lava tubes at Marius Hills on the Moon by SELENE (Kaguya) Lunar Radar Sounder", recently appeared in the journal *Geophysical Research Letters.* The team consisted of members from JAXA's Institute of Space and Astronautical Science (ISAS), Purdue University, the University of Alabama, AstroLabs, the National Astronomical Observatory of Japan(NOAJ) and multiple Japanese Universities.

Together, they examined data from the *SELENE* mission's Lunar Radar Sounder (LRS) from locations that were close to the Marius Hills Hole (MHH) to determine if the region hosted stable lava tubes. Such tubes are a remnant from the Moon's past, when it was still volcanically active. These underground channels are believed to be an ideal location for a lunar colony, and for several reasons.

For starters, their thick roofs would provide natural shielding from solar radiation, cosmic rays, meteoric impacts, and the Moon's extremes in temperature. These tubes, once enclosed, could also be pressurized to create a breathable environment. As such, finding an entrance to a stable lava tube would the first step towards selecting a possible site for such a colony.

As Junichi Haruyama, a senior researcher at JAXA and one of the co-authors on the study, explained in a University of Purdue press release:

*"It's important to know where and how big lunar lava tubes are if we're ever going to construct a lunar base. But knowing these things is also important for basic science. We might get new types of rock samples, heat flow data and lunar quake observation data."*

Granted, the LRS was not specifically designed to detect lava tubes, but to characterize the origins of the Moon and its geologic evolution. For this reason, it did not fly close enough to the Moon to obtain extremely accurate information on the subsurface. Nevertheless, as SELENE passed near the Marius Hills Hole, the instrument picked up a distinctive echo pattern.

This pattern was characterized by a decrease in echo power followed by a large second echo peak. These two echoes correspond to radar reflections from the Moon's surface, as well as the floor and ceiling of the open lava tube. When they analyzed this pattern, the research team interpreted it is evidence of a tube. They found similar echo patterns at several locations around the hole, which could indicate that there is more than one lava tube in the region.

To confirm their findings, the team also consulted data from NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission. Consisting of two spacecraft, this collaborative effort collected high-quality data on the Moon's gravitational field between 2011 and 2012. By using GRAIL data that identified mass deficits under the surface, which are evidence of caverns, the team was able to narrow down their search.

Jay Melosh, a GRAIL co-investigator and Distinguished Professor of Earth, Atmospheric and Planetary Sciences at Purdue University, was also a co-author on the paper. As he explained:

*"They knew about the skylight in the Marius Hills, but they didn't have any idea how far that underground cavity might have gone. Our group at Purdue used the gravity data over that area to infer that the opening was part of a larger system. By using this complimentary technique of radar, they were able to figure out how deep and high the cavities are."*

On Earth, stable lava tubes have been found that can extend for dozens of kilometers. To date, the longest and deepest to be discovered is the Kazumura Cave in Hawaii, which is over a kilometer (3,614 feet) deep and 65.5 km (40.7 mi) long. On the Moon, however, lava tubes are much larger, due to the fact that the Moon has only a fraction of the Earth's gravity (0.1654 *g* to be exact).

For a lava tube to be detecting using gravity data, it would need to be several kilometers in length and at least one kilometer in height and width. Since the tube in Marius Hills was detectable, it is likely big enough to house a major city. In fact, during a presentation at the 47th Lunar and Planetary Conference, researchers from Purdue University showed GRAIL data that indicated how the tube beneath the MHH could be large enough to house Philadelphia.

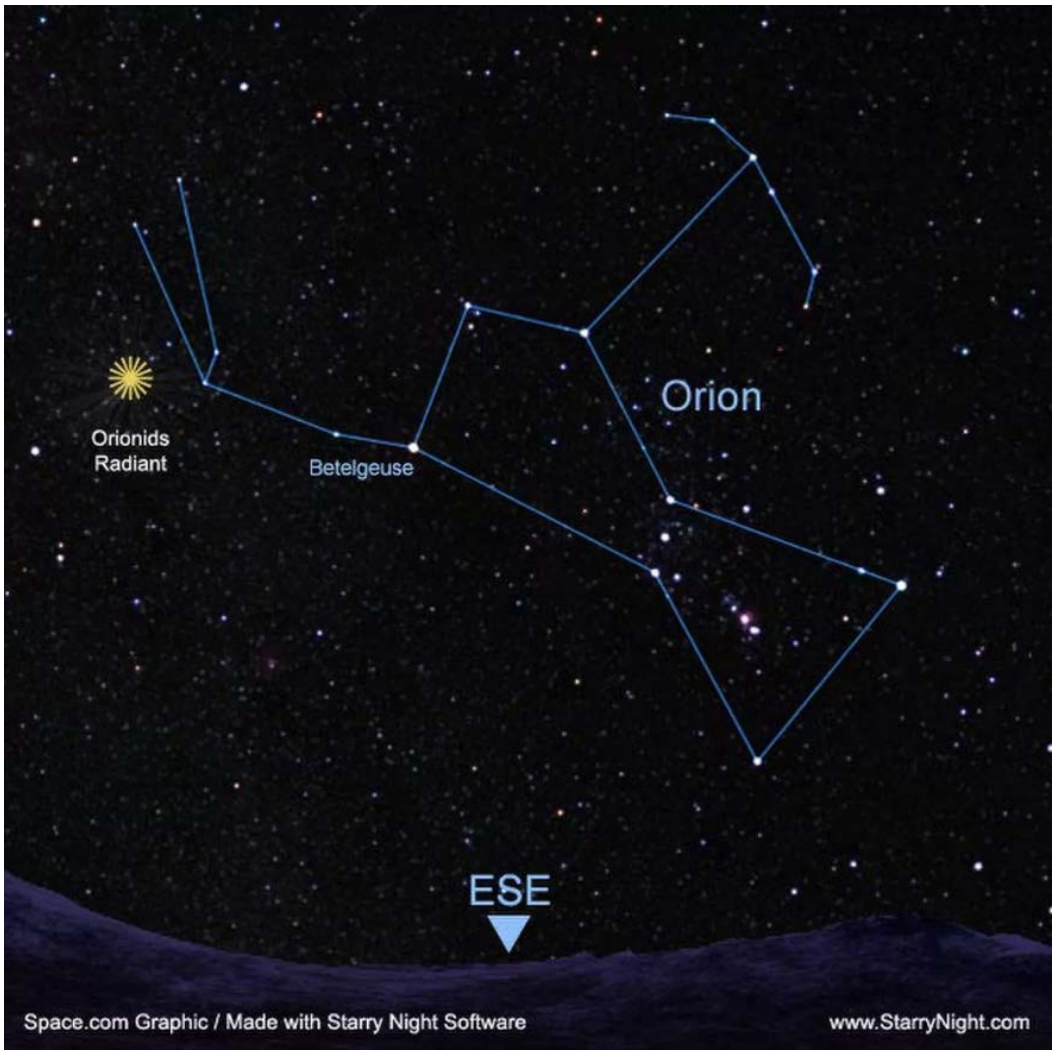
This most recent study was also the subject of a presentation at the 48th Lunar and Planetary Conference. Similar evidence of possible stable lava tubes in the Sea of Tranquility was also obtained by the Lunar Reconnaissance Orbiter (LRO) back in 2010. However, this latest combination of radar and gravity data has provided the clearest picture yet of what a stable lava tube looks like.

Similar evidence of lava tubes has also been discovered on Mars, and possible even Mercury. On Mars in particular, chains of pit craters, broad lava fans, skylights and partially collapsed lava tubes all indicate the presence of stable tubes. Based on this latest study, future mission to the Red Planet (which could include the creation of a habitat) might also entail the investigation of these features.

In fact, lava tubes could become the means through which a human presence is established throughout the Solar System someday!

Source: Universe Today Return to Contents

## 3. Orionid Meteor Shower 2017: When, Where & How to See It This Weekend




One of the year's best sky shows will peak this weekend between Oct. 20 and 22, when the Orionid meteor shower reaches its best viewing. The meteors that streak across the sky are some of the fastest and brightest among meteor showers, because the Earth is hitting a stream of particles almost head on.

The particles come from Comet 1P/Halley, better known as Halley's Comet. This famous comet swings by Earth every 75 to 76 years, and as the icy comet makes its way around the sun, it leaves behind a trail of comet crumbs. At certain times of the year, Earth's orbit around the sun crosses paths with the debris.

"You can see pieces of Halley's Comet during the Eta Aquarids [in May] and the Orionid meteor shower [in October and November]," NASA meteor expert Bill Cooke said.

The Orionids are named after the direction from which they appear to radiate, which is near the constellation Orion (The Hunter). In October, Orion is best visible around 2 a.m. Cooke told Space.com that the best viewing will be around that time on Oct. 21 and Oct. 22. Skywatchers in 2017 will not have moonlight to contend with, as the first-quarter moon will have set long before the meteors put on their best show. If you miss the peak, the show is also visible between Oct. 15 and 29, as long as the moon isn't washing the meteors out.

Sometimes the shower peaks at 80 meteors an hour; at others it is closer to 20 or 30. Cooke predicted that in 2017, the peak would be at the smaller end of the scale, echoing the peaks of 2016 and years before.

## How to view the show

Orionid meteors are visible from anywhere on Earth and can be seen anywhere across the sky. If you find the shape of Orion the Hunter, the meteor shower's radiant (or point of origin) will be near Orion's sword, slightly north of his left shoulder (the star Betelgeuse). But don't stare straight at this spot, Cooke said, "because meteors close to the radiant have short trails and are harder to see — so you want to look away from Orion."

As is the case with most nighttime skywatching events, light pollution can hinder your view of the Orionid meteor shower. If possible, get far away from city lights (which can hinder the show). Go out around 1:30 a.m. and let your eyes adjust to the dark for about 20 minutes. Bundle up against the cold if necessary. Lie back and use only your eyes to watch the sky. Binoculars and telescopes won't improve the view, because they are designed to see more stationary objects in the sky.

Some Orionids will appear very fast and bright, since they can whiz by at up to 148,000 mph (238,000 km/h) in relative speed. That's just six kilometers an hour slower than the Leonids, the speediest show of the year, Cooke said.

It's tempting to think that the brighter meteors represent fragments that would reach the ground, but Cooke said that isn't the case with the Orionids. These tiny comet fragments — some as small as a grain of sand — are called meteoroids. When they enter Earth's atmosphere, they become meteors. Friction from air resistance causes meteors to heat up, creating a bright, fiery trail commonly referred to as a shooting star. Most meteors disintegrate before making it to the ground. The few that do strike the Earth's surface are called meteorites.

## Cometary origins

Astronomers have recorded Halley's Comet as far back as 240 B.C. but no one realized that the same comet was making multiple appearances. In 1705, then-University of Oxford professor and astronomer Edmund Halley published "Synopsis Astronomia Cometicae" ("A Synopsis of the Astronomy of Comets"), which showed the first evidence that the comet is reoccurring. By studying the historical records of a comet that appeared in 1456, 1531, 1607 and 1682, Halley calculated that it was in fact the same comet and predicted it would reappear in 1758. While Halley died before the comet's return, it did appear on schedule and was named after him.

Reports of the Orionids, however, did not first appear until 1839 when an American in Connecticut spotted the shower, Cooke said. More observations of the shower were recorded during the Civil War between 1861 and 1865. Cooke told Space.com he wasn't sure why the meteor shower was discovered so late, given that records of Halley's Comet exist for millennia.

The next perihelion (closet approach of Halley's Comet to the sun) is expected around July 2061.

Source: Space.com Return to Contents

# The Night Sky

**Friday, October 20**


• The modest Orionid meteor shower continues in the early-morning hours for the next couple of nights. The apparent radiant point of the shower is near Orion's Club, low in the east after midnight and high in the south by the beginning of dawn. The morning sky is free of moonlight.
See Orionid Meteors Max Out Sunday Morning.

• Look for Capella sparkling low in the northeast after dinnertime this week. Then find the little Pleiades cluster to its right by about three fists at arm's length. They rise higher as evening grows late, harbingers of the cold months to come.

Upper right of Capella, and upper left of the Pleiades, the stars of Perseus stand astride the Milky Way. To the upper left of Perseus, the Milky Way runs through Cassiopeia.

**Saturday, October 21**

• After dark, spot the W of Cassiopeia high in the northeast. It's standing almost on end. The third segment of the W, counting down from the top, points almost straight down. Extend that segment twice as far down as its own length, and you're at the Double Cluster in Perseus. This pair of star-swarms is dimly apparent to the unaided eye in a dark sky (use averted vision), and it's visible from almost anywhere with binoculars. It's a lovely sight in telescopes.

**Sunday, October 22**

• This is the time of year when the Big Dipper lies down horizontal low in the north-northwest after dark. How low? The farther south you are, the lower. Seen from 40° north (New York, Denver) even its bottom stars twinkle nearly ten degrees high. But at Miami (26° N) the entire Dipper skims along out of sight just below the northern horizon.

**Monday, October 23**

• Look low in the southwest in late twilight for Saturn glowing about 7° left of the waxing crescent Moon (as seen from North America), as shown here.

**Tuesday, October 24**

• Now, at dusk, Saturn appears about 6° to the lower right of the thickening Moon, as shown here.

Source: Sky & Telescope

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# ISS Sighting Opportunities

## For Denver:

No sightings for Denver through Oct. 25th.

Sighting information for other cities can be found at NASA's Satellite Sighting Information

# NASA-TV Highlights

**(all times Eastern Daylight Time)**

**6:30 a.m., Friday, October 20 -** Coverage of ISS Expedition 53 U.S. Spacewalk #46 (Spacewalk begins at 8:05 a.m. ET, expected to last 6 ½ hours; Bresnik and Acaba) (all channels)

**11 a.m., Monday, October 23 -** ISS Expedition 53 Educational In-Flight Event with the New Prospect Elementary School in Alpharetta, Georgia and Commander Randy Bresnik and Flight Engineers Joe Acaba and Mark Vande Hei of NASA (starts at 10:50 a.m.) (all channels)

Watch NASA TV on the Net by going to the NASA website.

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# Space Calendar

- Oct 20 - Comet 337P/WISE Closest Approach To Earth (2.766 AU)
- Oct 20 - Comet C/2015 V1 (PANSTARRS) At Opposition (3.307 AU)
- Oct 20 - Comet C/2015 V1 (PANSTARRS) Closest Approach To Earth (3.307 AU)
- Oct 20 - Comet 228P/LINEAR At Opposition (3.438 AU)
- Oct 20 - [Oct 19] Apollo Asteroid 2017 UG Near-Earth Flyby (0.011 AU)
- Oct 20 - Apollo Asteroid 2017 SH14 Near-Earth Flyby (0.036 AU)
- Oct 20 - NEW [Oct 13] Apollo Asteroid 2017 TO2 Near-Earth Flyby (0.036 AU)
- Oct 20 - Amor Asteroid 2017 SY20 Near-Earth Flyby (0.048 AU)
- Oct 20 - Aten Asteroid 2014 UR Near-Earth Flyby (0.064 AU)
- Oct 20 - Asteroid 11836 Eileen Closest Approach To Earth (0.779 AU)
- Oct 20 - Asteroid 30439 Moe Closest Approach To Earth (1.658 AU)
- Oct 20 - Asteroid 4446 Carolyn Closest Approach To Earth (2.679 AU)
- Oct 20 - Christopher Wren's 385th Birthday (1632)
- Oct 21 - Orionids Meteor Shower Peak
- Oct 21 - Comet 73P-AC/Schwassmann-Wachmann At Opposition (1.395 AU)
- Oct 21 - Comet P/2013 YG46 (Spacewatch) At Opposition (1.728 AU)
- Oct 21 - Comet 159P/LONEOS At Opposition (2.844 AU)
- Oct 21 - Comet 258P/PANSTARRS At Opposition (3.803 AU)
- Oct 21 - NEW [Oct 16] Apollo Asteroid 2017 TG4 Near-Earth Flyby (0.012 AU)
- Oct 21 - NEW [Oct 16] Apollo Asteroid 2017 TC5 Near-Earth Flyby (0.040 AU)
- Oct 21 - NEW [Oct 16] Aten Asteroid 2017 TG5 Near-Earth Flyby (0.055 AU)
- Oct 21 - NEW [Oct 19] Apollo Asteroid 2017 TL6 Near-Earth Flyby (0.066 AU)
- Oct 21 - Asteroid 69263 Big Ben Closest Approach To Earth (1.152 AU)
- Oct 21 - Asteroid 1584 Fuji Closest Approach To Earth (1.622 AU)
- Oct 21 - Yerkes Observatory's 120th Birthday (1897)
- Oct 22 - Comet P/1998 VS24 (LINEAR) At Opposition (2.470 AU)
- Oct 22 - Dwarf Planet Ceres Occults TYC 1943-00104-1 (12.1 Magnitude Star)
- Oct 22 - NEW [Oct 17] Apollo Asteroid 2017 TV5 Near-Earth Flyby (0.009 AU)
- Oct 22 - NEW [Oct 17] Apollo Asteroid 2017 TQ5 Near-Earth Flyby (0.014 AU)
- Oct 22 - Apollo Asteroid 171576 (1999 VP11) Near-Earth Flyby (0.015 AU)
- Oct 22 - NEW [Oct 16] Apollo Asteroid 2017 TQ4 Near-Earth Flyby (0.029 AU)
- Oct 22 - Apollo Asteroid 2010 VT11 Near-Earth Flyby (0.092 AU)
- Oct 22 - Asteroid 4701 Milani Closest Approach To Earth (1.334 AU)
- Oct 22 - Asteroid 5661 Hildebrand Closest Approach To Earth (2.607 AU)
- Oct 22 - Asteroid 227 Philosophia Closest Approach To Earth (2.730 AU)
- Oct 22 - Kuiper Belt Object 308379 (2005 RS43) At Opposition (42.562 AU)
- Oct 22 - 25th Anniversary (1992), STS-52 Launch (Space Shuttle Columbia, LAGEOS II)
- Oct 23 - Comet 96P/Machholz Closest Approach To Earth (0.879 AU)
- Oct 23 - Comet P/1998 VS24 (LINEAR) Closest Approach To Earth (2.470 AU)
- Oct 23 - Apollo Asteroid 2017 ST17 Near-Earth Flyby (0.076 AU)
- Oct 23 - Comet C/2017 C2 (PANSTARRS) Closest Approach To Earth (2.999 AU)
- Oct 23 - NEW [Oct 19] Aten Asteroid 2017 TK6 Near-Earth Flyby (0.049 AU)
- Oct 23 - Apollo Asteroid 2008 GH110 Near-Earth Flyby (0.087 AU)
- Oct 23 - Asteroid 8992 Magnanimity Closest Approach To Earth (1.189 AU)
- Oct 23 - Aten Asteroid 3362 Khufu Closest Approach To Earth (1.281 AU)
- Oct 23 - Asteroid 7644 Cslewis Closest Approach To Earth (1.288 AU)
- Oct 23 - Asteroid 13606 Bean Closest Approach To Earth (1.593 AU)
- Oct 23 - Asteroid 15092 Beegees Closest Approach To Earth (2.018 AU)

- Oct 23 - Neptune Trojan 2011 SO277 At Opposition (29.506 AU)
- Oct 23 - 10th Anniversary (2007), STS-120 Launch (Space Shuttle Discovery, International Space Station)

Source: JPL Space Calendar

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# Food for Thought

## Space greens beat the blues

Where people will go in the cosmos, plants will go. That's the message of a paper entitled "Gardening for Therapeutic People-Plant Interactions during Long-Duration Space Missions" written by Raymond Odeh, and Charles L. Guy of the University of Florida (Gainesville) and published in the De Gruyter journal, *Open Agriculture*.

In the beginning of the space age, researchers sought to see if plants could survive in a zero-gravity atmosphere and scientific curiosity was the main driver of this research. However, the realization that it would be more cost effective and healthier to grow fresh fruits and vegetables on demand during a long space mission, rather than to rely on processed foods, also played a role. Once it was established that plants could survive, more experiments were conducted to see if they could be used in other ways, such as for purifying the air inside a spacecraft since plants consume carbon dioxide and produce oxygen and clean the air of pollutants.

The paper reveals even more surprising results. Plants may also play a key role in maintaining the psychological well-being of space crews. The next frontier of space plant experimentation is to examine the psychological impact of plant life on astronauts.

Space travel can cause sleep disorders, a reduction in energy, inattentiveness and difficulty in problem-solving, and even memory loss. It can cause people to be more hostile, act more impulsively and, despite the danger and excitement, is sometimes boring. Any of these conditions and problems can lead to dangerous, if not tragic outcomes.

Odeh and Guy have written a review of the existing literature on plant-people interactions. On Earth, there are about 600 species of economically useful plants, and 7000 edible species in total. That number is dwarfed by the number of species that are used for gardening and landscaping - 28,000. These species have been taken all over the world and adapted to different climates. So clearly we get something from plants other than food and medicine, the question the paper seeks to answer is: what do we get, and how we can apply it to space travel?

Numerous studies show that gardening or even just the presence of plants has a positive psychological effect on people, making them happier and more social. Gardening helps people spend time with nature, relax and learn new skills. The research the authors have uncovered also shows that humans have a tendency to look for natural life, referred to as the Biophilia Hypothesis, which might help to explain why space travel can be so dangerous for the human psyche.

The authors conclude that what applies to humans on Earth also applies to astronauts in space. Plants can help reduce both social and cognitive problems associated with space travel, and suggest that plants should be part of the design of future space missions for both nutritional - and psychological - reasons. Peggy Whitson, an astronaut aboard the ISS, confirms this: "It was surprising to me how great 6 soybean plants looked... I guess seeing something green for the first time in a month and a half had a real effect. From a psychological perspective, I think it's interesting that the reaction was as dramatic as it was... guess if we go to Mars, we need a garden!"

Dr. Raymond Wheeler, a senior scientist for NASA at the Kennedy Space Centre has this to say about the paper: "A review of this topic for space research is long overdue, and should provide a strong argument to systems analysts and biomedical researchers to look more closely at the "other" contributions of plants to exploration of space. I highly recommend this paper for anyone who has an interest in human space travel, and the notion of using plants for bioregenerative life support."

Source: EurekAlert Return to Contents

# Space Image of the Week


**Stars and Dust in Corona Australis**
**Image Credit & Copyright:** Eric Coles & Martin Pugh

**Explanation:** Blue dust clouds and young, energetic stars inhabit this telescopic vista, less than 500 light-years away toward the northern boundary of Corona Australis, the Southern Crown. The dust clouds effectively block light from more distant background stars in the Milky Way. But the striking complex of reflection nebulas cataloged as NGC 6726, 6727, and IC 4812 produce a characteristic blue color as light from the region's bright blue stars is reflected by the cosmic dust. The dust also obscures from view stars still in the process of formation. At the left, smaller yellowish nebula NGC 6729 bends around young variable star R Coronae Australis. Just below it, glowing arcs and loops shocked by outflows from embedded newborn stars are identified as Herbig-Haro objects. On the sky this field of view spans about one degree, corresponding to almost nine light-years at the estimated distance of the nearby star forming region.

Source: APOD

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