Contents

In the News

Story 1:
Mars InSight's 'Mole' Is Moving Again

Story 2:
Failed Battery Charge/Discharge Unit replacement spacewalk begins

Story 3:
Hubble observes interstellar visitor

Departments

The Night Sky
ISS Sighting Opportunities
Space Calendar
NASA-TV Highlights
Food for Thought
Space Image of the Week
NASA's InSight spacecraft has used its robotic arm to help its heat probe, known as "the mole," dig nearly 2 centimeters (3/4 of an inch) over the past week. While modest, the movement is significant: Designed to dig as much as 16 feet (5 meters) underground to gauge the heat escaping from the planet's interior, the mole has only managed to partially bury itself since it started hammering in February 2019.

The recent movement is the result of a new strategy, arrived at after extensive testing on Earth, which found that unexpectedly strong soil is holding up the mole's progress. The mole needs friction from surrounding soil in order to move: Without it, recoil from its self-hammering action will cause it to simply bounce in place. Pressing the scoop on InSight's robotic arm against the mole, a new technique called "pinning," appears to provide the probe with the friction it needs to continue digging.

Since Oct. 8, 2019, the mole has hammered 220 times over three separate occasions. Images sent down from the spacecraft's cameras have shown the mole gradually progressing into the ground. It will take more time - and hammering - for the team to see how far the mole can go.

The mole is part of an instrument called the Heat Flow and Physical Properties Package, or HP³, which was provided by the German Aerospace Center (DLR).

"Seeing the mole's progress seems to indicate that there's no rock blocking our path," said HP³Principal Investigator Tilman Spohn of DLR. "That's great news! We're rooting for our mole to keep going."

NASA's Jet Propulsion Laboratory in Pasadena, California, leads the InSight mission. JPL has tested the robotic arm's movement using full-scale replicas of InSight and the mole. Engineers continue to test what would happen if the mole were to sink beneath the reach of the robotic arm. If it stops making progress, they might scrape soil on top of the mole, adding mass to resist the mole's recoil.

If no other options exist, they would consider pressing the scoop down directly on the top of the mole while trying to avoid the sensitive tether there; the tether provides power to and relays data from the instrument.

"The mole still has a way to go, but we're all thrilled to see it digging again," said Troy Hudson of JPL, an engineer and scientist who has led the mole recovery effort. "When we first encountered this problem, it was crushing. But I thought, 'Maybe there's a chance; let's keep pressing on.' And right now, I'm feeling giddy."

Source: JPL
NASA astronauts Christina Koch and Dr. Jessica Meir have exited the International Space Station to begin an Extravehicular Activity – EVA, or spacewalk – that will largely see the duo replace a failed Battery Charge/Discharge Unit on the Station’s P6 truss structure.

The unit failed to reactivate after the first two of a five spacewalk sequence to replace 12 old batteries with six new and improved Lithium-ion batteries.

**Unit failure:**

Overall, the International Space Station has 24 Battery Charge/Discharge Units (BCDUs) along its Integrated Truss Structure – the part of the Station that houses the solar arrays and all of the batteries and electrical distribution systems for the outpost.

BCDUs control the amount of charge put into each battery on the Station’s truss during the 16 sunlight orbital passes each day as well as the amount of power taken off the batteries during the 16 orbital night passes each day.

In preparation for the first two EVAs earlier this month to begin the battery replacement sequence on the P6 truss, three BCDUs on the same power channel as the first batteries to be replaced were turned off.

Last Friday, all three were commanded to reactivate as their associated batteries had completed their replacement sequence.

Two of the BCDUs reactivated without issue, but a third failed to do so.
According to NASA, “On Friday, October 11th, after the completion of US EVA 57 P6 Battery EVA #2, the BCDU 2B2 converter did not close when commanded. The Li-ion battery connected to BCDU 2B2 was safed and still shows good health & status.

“The other two BCDUs, 2B1 & 2B3, were successfully activated and are healthy and nominal. BCDU 2B2 troubleshooting was completed ... to power cycle the BCDU and the converter; however, it was not recovered.”

This resulted in only two-thirds of the potential power from this particular BCDU/battery channel being available for the Station.

When the failure occurred, NASA decided to stop the current battery replacement spacewalks and change the next EVA in the sequence to a removal and replacement operation for the failed BCDU.

While a single failed BCDU might not seem like a critical issue, it follows on the heels of a similar failure earlier this year when a BCDU on a channel of newly replaced batteries failed as well.

A second failure in rapid succession opens the question as to the exact cause of the BCDU failures, if they are connected, and if they are in someway related to the spacewalks or the new Lithium-ion batteries.

The previous failed BCDU was resolved when the Station’s Canadarm2 performed a removal and replacement operation robotically.

That robotic activity is not an option for the currently failed BCDU as it is located on the extremity of the Station’s Integrated Truss Structure, out of reach of Canadarm2.

The removal and replacement process is also not possible using the Orbiter Boom Sensor System (OBSS) arm left behind by Shuttle Endeavour after her final mission in May 2011.

The OBSS was left on the Station to allow an extended reach of Canadarm2 to extreme points on the Station in certain situations.

This is not one of those situations as the OBSS does not have controllable grapple fixtures to allow it to grab items on the Station – as required for the removal and replacement activities associated with the failed BCDU.

With the need to manually replace the BCDU, NASA re-evaluated US EVA-58 – which was originally the third spacewalk in the P6 battery replacement sequence.

During this re-evaluation, NASA decided to change the astronauts assigned to the spacewalk by removing Dr. Andrew Morgan and replacing him with Christina Koch.

Koch is tied with Morgan as the most experienced US-segment spacewalker currently aboard the International Space Station – with three EVAs to each of their credit.

However, all three of Koch’s EVAs have dealt with the Station’s power and electrical distribution systems, whereas only two of Dr. Morgan’s have done so.

Replacing Dr. Morgan with Koch exemplified NASA’s commitment to putting the most qualified astronaut on a spacewalk.

Dr. Morgan’s replacement with Christina Koch subsequently paired her with Dr. Jessica Meir, who was already slated to perform U.S. EVA-58 under its original plan.
Another reason for removing Dr. Morgan from this EVA is that he is slated to perform five back-to-back spacewalks in November and December with European astronaut and current Station Commander Luca Parmitano to repair the Alpha Magnetic Spectrometer experiment.

The first and foremost task of the BCDU replacement EVA will see Koch and Dr. Meir translate out to the P6 truss and perform a manual replacement.

In preparation for this activity, the Station’s Canadarm2, with the spare BCDU, translated yesterday to the appropriate area as close to the P6 truss as it can get.

The replacement operation is expected to last just over three hours, after which Koch and Dr. Meir will perform a rearrangement of Multi-Layer Insulation blankets on other elements of the Station’s power system.

After that, the duo will translate back to the central core of the Station and then outward to the European Space Agency’s Columbus laboratory where they will prepare the “porch” section of the module to accept future external payloads.

After the replacement activities of the BCDU, there will only be two or three remaining BCDU spares on the Station and none on the ground, according to NASA in a teleconference detailing today’s spacewalk.

According to NASA, the failed BCDU will be brought inside the Station and prepared for a now-planned return to Earth in early-January 2020 aboard the SpaceX CRS-19 cargo Dragon – the only craft currently capable of returning payloads from the International Space Station.

But a much larger and critical question now faces the International Space Station Program: what is causing the BCDU failures and are there any links to the new Lithium-ion batteries being installed on the outpost?

Until some kind of answer can be determined, the current battery replacement sequence is on hold.

As of publication, there are no plans to delay the pending 31 October Russian EVA nor is there any, at-present, interference with the planned 2 November launch of the Northrop Grumman Cygnus resupply cargo craft to the Station.

More so, NASA says the BCDU failure and investigation will not affect the planned five spacewalk series in November and December to repair the Alpha Magnetic Spectrometer experiment that was mounted to the outside of the Station in May 2011 during the STS-134 flight of the Space Shuttle Endeavour.

Source: NASASpaceflight.com
The Hubble Space Telescope has returned an image of a comet that originated outside our solar system, providing astronomers with their best view yet of an interstellar visitor at a distance of 260 million miles from Earth.

Hubble observed Comet 2I/Borisov on Oct. 12 as the object barreled through the solar system at a speed of some 110,000 mph (49 kilometers per second). The Hubble image revealed a bright cloud of dust around the object’s nucleus, an appearance astronomers say is remarkably similar to comets resident in our own solar system.

Scientists have confirmed the object originated beyond our solar system by tracking its movement, allowing experts to propagate its course back in time. Comet 2I/Borisov is following a hyperbolic trajectory, and will head back into interstellar space after making its closest approach to the sun Dec. 7, at a distance twice as far from the sun as Earth, according to NASA.

“Though another star system could be quite different from our own, the fact that the comet’s properties appear to be very similar to those of the solar system’s building blocks is very remarkable,” said Amaya Moro-Martin of the Space Telescope Science Institute in Baltimore.

Comet 2I/Borisov is the second interstellar object detected passing through our solar system, an occurrence long predicted by astronomers.

An object named ‘Oumuamua, or 1I/2017 U1, was discovered in October 2017, weeks after it make its closest pass to the sun. Scientists confirmed ‘Oumuamua came from interstellar space, and it had an unusual elongated shape, like a cigar or a frisbee.

“Whereas ‘Oumuamua appeared to be a rock, Borisov is really active, more like a normal comet. It’s a puzzle why these two are so different,” said David Jewitt of the University of California, Los Angeles, leader of the Hubble team who observed the comet.
All comets studied before 2I/Borisov came from the Kuiper Belt, a ring of icy debris beyond Neptune’s orbit, or from the Oort Cloud, a spherical shell of icy objects located between 200 billion miles (320 billion kilometers) and 9 trillion miles (14 trillion kilometers) from the sun.

Gennady Borisov, a Crimean amateur astronomer, discovered the comet Aug. 30. After confirming the comet’s interstellar origin, professional astronomers used ground-based observatories for detailed observations.

In a study published Oct. 14 in Nature Astronomy, Polish astronomers wrote that the comet has a reddish hue and a solid nucleus about 1 kilometer, or 3,300 feet, in diameter.

“Make of this what you will, but based on these initial characteristics, this object appears indistinguishable from the native solar system comets,” said Piotr Guzik of the Jagiellonian University, who led the study.

“We immediately noticed the familiar coma and tail that were not seen around ‘Oumuamua,” said Michal Drahus of the Jagiellonian University, who co-led the study with Guzik. “This is really cool because it means that our new visitor is one of these mythical and never-before-seen ‘real’ interstellar comets.”

The comet is getting brighter as it travels closer to the sun, so additional observations could reveal more details. Astronomers plan to observe the comet in the coming months with ground-based telescopes and Hubble.

“We can safely say that research on this body will be transformative for planetary astronomy and a milestone for astronomy in general,” Guzik said in a statement.

Although astronomers have detected only two interstellar objects traveling through the solar system, scientists believe such interlopers are regular visitors. But they are often dim and move extremely fast, making their detection difficult.

“New comets are always unpredictable,” said Max Mutchler, another member of the Hubble observing team. “They sometimes brighten suddenly or even begin to fragment as they are exposed to the intense heat of the Sun for the first time. Hubble is poised to monitor whatever happens next with its superior sensitivity and resolution.”

Source: Spaceflight Now
The Night Sky

Friday, Oct. 18
• Vega is the brightest star high in the west after dark. To its lower right by 14° (nearly a fist and a half at arm's length), look for Eltanin, the nose of Draco the Dragon. The rest of Draco's fainter, lozenge-shaped head is a little farther behind. Draco always eyes Vega.

The main stars of Vega's own constellation, Lyra — quite faint by comparison — extend to Vega's left (by 7°).

Saturday, Oct. 19
• Vega shines high in the west after dark. About equally high in the southwest is Altair, not quite as bright. Just upper right of Altair, by a finger-width at arm's length, spot little orange Tarazed. Down from Tarazed runs the stick-figure backbone of Aquila, the Eagle.

Sunday, Oct. 20
• Spot Altair high in the southwest soon after dark. Two distinctive little constellations lurk above it: Delphinus the Dolphin, hardly more than a fist at arm's length to Altair's upper left, and fainter Sagitta the Arrow, slightly less far to Altair's upper right. Sky too bright? Use binoculars!

• At dawn on Monday the 21st the Moon is just a few hours from being exactly last quarter, as shown here. See next entry.

Monday, Oct. 21
• Last-quarter Moon; exactly so at 8:39 a.m. EDT. Many hours later, when the Moon rises around midnight or 1 a.m. tonight, the Moon's terminator will already be looking just a little concave. The Moon will then be in dim Cancer, below Castor and Pollux and left of Procyon.

Binoculars will not only show the shape of the terminator better, they should also reveal the loose Beehive Star Cluster just a few degrees from the Moon within the same binocular field of view — if the air is sufficiently clear and clean.
By dawn Tuesday morning the Moon will be high in the southeast.

Tuesday, Oct. 22
• Deneb is the zenith star after nightfall (for skywatchers at mid-northern latitudes). Brighter Vega shines to its west. Altair shines farther down to Deneb's south-southwest.

While it's still twilight, draw a line from Deneb through the midpoint between Vega and Altair. Keep following this line way down, and you'll hit Jupiter low in the southwest, on its way to setting.

Source: Sky & Telescope
ISS Sighting Opportunities

For Denver:

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

NASA-TV Highlights
(all times Eastern Daylight Time)

October 18, Friday
6:30 a.m. – Coverage of International Space Station Expedition 61 U.S. spacewalk #58 to replace a battery charge/discharge unit (Koch and Meir); spacewalk begins at 7:50 a.m. EDT (All Channels)

October 21, Monday
9 am – 70th International Astronautical Congress Opening Ceremonies (All Channels)
12:00-12:30 p.m. – ISS Expedition 61 Crew News Conference with NASA Flight Engineers Christina Koch and Jessica Meir (All Channels)
1:15 p.m. – International Astronautical Congress: Space Agencies: Challenges and Opportunities in Challenging Space Environment (All Channels)

October 22, Tuesday
8:30 a.m. – International Astronautical Congress: Long-Term Sustainability of Outer Space – Advancing Space Economy (All Channels)

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

- Oct 18 - Apollo Asteroid 2019 TE2 Near-Earth Flyby (0.021 AU)
- Oct 18 - [Oct 11] Apollo Asteroid 2019 TP5 Near-Earth Flyby (0.021 AU)
- Oct 18 - [Oct 14] Apollo Asteroid 2019 TM7 Near-Earth Flyby (0.021 AU)
- Oct 18 - [Oct 12] Apollo Asteroid 2019 TW6 Near-Earth Flyby (0.037 AU)
- Oct 18 - Apollo Asteroid 2019 TA1 Near-Earth Flyby (0.039 AU)
- Oct 18 - Apollo Asteroid 14827 Hypnos Closest Approach To Earth (0.846 AU)
- Oct 18 - Aten Asteroid 3362 Khufu Closest Approach To Earth (1.387 AU)
- Oct 18 - Dwarf Planet 136199 Eris At Opposition (95.047 AU)
- Oct 18 - Christian Friedrich Schonbein's 220th Birthday (1799)
- Oct 18-20 - NASA Space Apps Challenge 2019
- Oct 19 - Comet C/2018 N2 (ASASSN) At Opposition (2.212 AU)
- Oct 19 - Comet 200P/Larsen At Opposition (2.339 AU)
- Oct 19 - Comet P/2017 P1 (PANSTARRS) At Opposition (4.786 AU)
- Oct 19 - [Oct 12] Apollo Asteroid 2019 TG7 Near-Earth Flyby (0.043 AU)
- Oct 19 - Amor Asteroid 3102 Krok Closest Approach To Earth (0.694 AU)
- Oct 19 - Asteroid 12325 Bogota Closest Approach To Earth (1.226 AU)
- Oct 19 - Amor Asteroid 2608 Seneca Closest Approach To Earth (2.972 AU)
- Oct 20 - Mercury At Its Greatest Eastern Elongation (25 Degrees)
- Oct 20 - Comet 354P/LINEAR At Opposition (1.159 AU)
- Oct 20 - Comet C/2018 N2 (ASASSN) Closest Approach To Earth (2.212 AU)
- Oct 20 - Comet P/2007 B1 (Christensen) At Opposition (3.254 AU)
- Oct 20 - Apollo Asteroid 2019 SJ8 Near-Earth Flyby (0.030 AU)
- Oct 20 - Apollo Asteroid 6489 Golevka Closest Approach To Earth (1.533 AU)
- Oct 20 - Asteroid 9674 Slovenija Closest Approach To Earth (1.786 AU)
- Oct 20 - Kuiper Belt Object 202421 (2005 UQ513) At Opposition (47.065 AU)
- Oct 20 - 25th Anniversary (1994), Coleman Meteorite Fall (Hit House in Michigan)
- Oct 20-23 - New Zealand Starlight Conference, Lake Tekapo, New Zealand
- Oct 21 - Orionids Meteor Shower Peak
- Oct 21 - Hyperbolic Object A/2019 Q1 Closest Approach To Earth (4.443 AU)
- Oct 21 - Asteroid 253 Mathilde Occults 2UCAC 36985971 (11.9 Magnitude Star)
- Oct 21 - Asteroid 5860 Deankootz Closest Approach To Earth (0.962 AU)
- Oct 21 - Asteroid 1388 Aphrodite Closest Approach To Earth (1.952 AU)
- Oct 21 - Asteroid 100007 Peters Closest Approach To Earth (2.247 AU)
- Oct 22 - Comet P/2013 A2 (Scotti) Closest Approach To Earth (2.884 AU)
- Oct 22 - Apollo Asteroid 2017 MN8 Near-Earth Flyby (0.093 AU)
- Oct 22 - Asteroid 8084 Dallas Closest Approach To Earth (2.366 AU)
- Oct 22 - Max Beyer's 125th Birthday (1894)

Source: JPL Space Calendar

Return to Contents
Food for Thought

The clumpy and lumpy death of a star

In 1572, Danish astronomer Tycho Brahe was among those who noticed a new bright object in the constellation Cassiopeia. Adding fuel to the intellectual fire that Copernicus started, Tycho showed this "new star" was far beyond the Moon, and that it was possible for the Universe beyond the Sun and planets to change.

Astronomers now know that Tycho's new star was not new at all. Rather it signaled the death of a star in a supernova, an explosion so bright that it can outshine the light from an entire galaxy. This particular supernova was a Type Ia, which occurs when a white dwarf star pulls material from, or merges with, a nearby companion star until a violent explosion is triggered. The white dwarf star is obliterated, sending its debris hurtling into space.

As with many supernova remnants, the Tycho supernova remnant, as it's known today (or "Tycho," for short), glows brightly in X-ray light because shock waves—similar to sonic booms from supersonic aircraft—generated by the stellar explosion heat the stellar debris up to millions of degrees. In its two decades of operation, NASA's Chandra X-ray Observatory has captured unparalleled X-ray images of many supernova remnants.

Chandra reveals an intriguing pattern of bright clumps and fainter areas in Tycho. What caused this thicket of knots in the aftermath of this explosion? Did the explosion itself cause this clumpiness, or was it something that happened afterward?

This latest image of Tycho from Chandra is providing clues. To emphasize the clumps in the image and the three-dimensional nature of Tycho, scientists selected two narrow ranges of X-ray energies to isolate material (silicon, colored red) moving away from Earth, and moving towards us (also silicon, colored blue). The other colors in the image (yellow, green, blue-green, orange and purple) show a broad range of different energies and elements, and a mixture of directions of motion. In this new composite image, Chandra's X-ray data have been combined with an optical image of the stars in the same field of view from the Digitized Sky Survey.
By comparing the Chandra image of Tycho to two different computer simulations, researchers were able to test their ideas against actual data. One of the simulations began with clumpy debris from the explosion. The other started with smooth debris from the explosion and then the clumpiness appeared afterwards as the supernova remnant evolved and tiny irregularities were magnified.

A statistical analysis using a technique that is sensitive to the number and size of clumps and holes in images was then used. Comparing results for the Chandra and simulated images, scientists found that the Tycho supernova remnant strongly resembles a scenario in which the clumps came from the explosion itself. While scientists are not sure how, one possibility is that star's explosion had multiple ignition points, like dynamite sticks being set off simultaneously in different locations.

Understanding the details of how these stars explode is important because it may improve the reliability of the use of Type Ia supernovas "standard candles"—that is, objects with known inherent brightness, which scientists can use to determine their distance. This is very important for studying the expansion of the universe. These supernovae also sprinkle elements such as iron and silicon, that are essential for life as we know it, into the next generation of stars and planets.

A paper describing these results appeared in the July 10th, 2019 issue of The Astrophysical Journal and is available online. The authors are Toshiki Sato (RIKEN in Saitama, Japan, and NASA's Goddard Space Flight Center in Greenbelt, Maryland), John (Jack) Hughes (Rutgers University in Piscataway, New Jersey), Brian Williams, (NASA's Goddard Space Flight Center), and Mikio Morii (The Institute of Statistical Mathematics in Tokyo, Japan).

Another team of astronomers, led by Gilles Ferrand of RIKEN in Saitama, Japan, has constructed their own three-dimensional computer models of a Type Ia supernova remnant as it changes with time. Their work shows that initial asymmetries in the simulated supernova explosion are required so that the model of the ensuing supernova remnant closely resembles the Chandra image of Tycho, at a similar age. This conclusion is similar to that made by Sato and his team.

A paper describing the results by Ferrand and co-authors appeared in the June 1st, 2019 issue of The Astrophysical Journal and is available online.

Source: Phys.org
**Space Image of the Week**

**Moons of Saturn**

**Image Credit:** Cassini Imaging Team, SSI, JPL, NASA

**Explanation:** On July 29, 2011 the Cassini spacecraft’s narrow-angle camera took this snapshot and captured 5 of Saturn's moons, from just above the ringplane. Left to right are small moons Janus and Pandora respectively 179 and 81 kilometers across, shiny 504 kilometer diameter Enceladus, and Mimas, 396 kilometers across, seen just next to Rhea. Cut off by the right edge of the frame, Rhea is Saturn's second largest moon at 1,528 kilometers across. So how many moons does Saturn have? Twenty new found outer satellites bring its total to 82 known moons, and since Jupiter's moon total stands at 79, Saturn is the Solar System's new moon king. The newly announced Saturnian satellites are all very small, 5 kilometers or so in diameter, and most are in retrograde orbits inclined to Saturn's ringplane. You can help name Saturn's new moons, but you should understand the rules. Hint: A knowledge of Norse, Inuit, and Gallic mythology will help.

Source: APOD

[Return to Contents]