Space News Update — December 15, 2015 —

Contents

In the News

Story 1:
Finally There: Akatsuki Probe Relays its First Images from Venus Orbit

Story 2:
New Horizons: Plunging through the Solar System’s Dust Disk

Story 3:
Study Finds Evidence for More Recent Clay Formation on Mars

Departments

The Night Sky
ISS Sighting Opportunities
NASA-TV Highlights
Space Calendar
Food for Thought
Space Image of the Week
Finally There: Akatsuki Probe Relays its First Images from Venus Orbit

The Akatsuki spacecraft’s ultraviolet camera took this image of Venus at 0519 GMT (12:19 a.m. EST) on Dec. 7 from a distance of 73,000 kilometers (45,000 miles). Credit: JAXA

Japanese scientists released Wednesday (December 9th) the first views of Venus captured by the Akatsuki spacecraft after arriving in orbit this week, setting the stage for regular observations of the planet’s blistering atmosphere over the next few years.

The Japanese space agency — JAXA — also confirmed Akatsuki is in a good orbit around Venus after a 20-minute firing of four of the spacecraft’s maneuvering thrusters beginning at 2351 GMT (6:51 p.m. EST) Sunday.

Engineers said Monday the make-or-break rocket burn appeared to go as planned, but it took two days for ground stations to carefully monitor Akatsuki’s trajectory and verify the parameters of its orbit.

The thruster firing placed Akatsuki in an elongated elliptical orbit ranging as far as 440,000 kilometers (273,000 miles) from Venus. At the low point of its orbit, Akatsuki passes about 400 kilometers (248 miles) above the planet, JAXA officials said Wednesday.

The orbit is slightly lower than anticipated, an indication that the maneuver outperformed expectations, generating extra impulse to drive Akatsuki on a path closer to Venus, officials said.
It takes about 13 days and 14 hours for Akatsuki to make one lap around the planet, down from the planned 15-day orbit time.

The spacecraft is orbiting Venus in the same direction of the planet’s rotation, at a three-degree angle to its equator. The inclination value is almost right on the mark compared to predictions.

Akatsuki entered orbit early Monday after a five-year sojourn through the solar system, a voyage that was extended after the craft missed an opportunity to enter orbit around Venus in December 2010. The mishap meant Akatsuki had to weather more extreme temperatures than planned, and engineers commanded the orbiter to fire its secondary thrusters for the critical Venus arrival maneuver after the failed 2010 burn damaged its main engine.

Engineers were cautiously optimistic as Akatsuki sped toward Venus, but managers acknowledged the maneuver was risky.

But the burn occurred without any problems, making Akatsuki the only space probe currently operating at Venus, and Japan’s first spacecraft to go into orbit around another planet.

Controllers activated three of Akatsuki’s five cameras before the spacecraft arrived at Venus, and JAXA published the first views from the imagers Wednesday. The probe’s other two cameras are scheduled to be switched on in the coming weeks.

The camera suite on Akatsuki, which is also named the Venus Climate Orbiter, includes two imagers to see Venus in two infrared wavelengths, a longwave infrared camera, an ultraviolet sensor, and an instrument to resolve potential lightning strikes in the Venusian atmosphere.

Each camera is designed to study a different part of the super-thick, sweltering atmosphere surrounding Venus and blocking camera views of its surface.

“From far distances, we continually monitor the global-scale dynamics of the atmosphere and clouds, and of course, from close distances, we take close-up images of the atmosphere, the surface, and we also observe lightning and airglow when the spacecraft is in the shadow of Venus,” said Takeshi Imamura, Akatsuki’s project scientist at JAXA’s Institute of Space and Astronautical Science.

The mission will observe climate and weather conditions on Venus, looking at cloud patterns just above the surface and the super-rotating cloud structures that dominate the upper atmosphere. The ultraviolet camera will also track sulfur dioxide, a precursor to cloud formation at Venus.

Scientists hope to see the surface of Venus with one of Akatsuki’s infrared cameras in a bid to find active volcanoes. The cocoon of clouds around Venus prevents visible cameras from ever seeing through to the ground.

The data stream from Akatsuki could also hold clues on how clouds form on Venus, with measurements of sulfur dioxide — a precursor to cloud formation — water vapor and carbon monoxide. Researchers also plan to measure radio waves transmitted through the planet’s atmosphere to measure its profile.

Akatsuki’s orbit is much farther from Venus than if the probe had entered orbit on time in 2010. The spacecraft’s attitude control thrusters had enough power to steer Akatsuki into orbit, but only its main engine could take it closer to Venus.

Imamura said engineers have uploaded new software to Akatsuki to better see Venus from the spacecraft’s higher-than-planned orbit, reducing the data volume coming back to Earth to streamline the mission’s scientific return.
“By combining this information, we can model the three-dimensional structure of the atmosphere and the clouds,” Imamura said.

Akatsuki’s ultraviolet camera, one-micron infrared imager and longwave infrared instrument are ready for observations, JAXA said Wednesday. The two-micron infrared camera, lightning detector and a radio oscillator for Akatsuki’s atmospheric profile measurements will be checked and put into operation now that the spacecraft is in orbit.

The mission’s ground team will guide Akatsuki closer to Venus over the next few months, eventually putting the probe in a nine-day orbit around the planet.

Regular observations are due to begin in April 2016, officials said.

Before Akatsuki arrived at Venus, Imamura said engineers predicted the spacecraft had enough fuel for at least two years of operations, but that could be refined after a tally of leftover propellant following this week’s big burn.
2. New Horizons: Plunging through the Solar System’s Dust Disk

This New Horizons Blog post is written by Jamey Szalay, a New Horizons graduate student at the University of Colorado Boulder. Jamey just completed his PhD at CU and has accepted a postdoc at SwRI to work on NASA’s next New Frontiers mission, JUNO, which arrives at Jupiter on July 4, 2016.

Jamey Szalay  
Credit: Kyle Cassidy

A model of the solar system’s dust disk, formed by grains generated at the Kuiper Belt. Credit: Han et al., 2011

For the last five and a half years, I’ve worked on the Student Dust Counter (SDC) instrument onboard New Horizons. SDC was the first student designed, built, and operated scientific instrument to travel aboard an interplanetary NASA mission. Working on SDC has been an incredibly rewarding experience.

SDC works a bit differently than the rest of the instruments aboard New Horizons. While the principal investigator, Professor Mihaly Horanyi of the University of Colorado, is ultimately responsible for the project, SDC is a student-run instrument. As such, the day-to-day operations are actually handled by graduate students. During the design and build phase of the instrument, the SDC team consisted of about 20-30 undergrad and grad students. Once our team delivered SDC to the spacecraft and launched, the team size was significantly reduced, down to one lead graduate student and one grad student trainee. I inherited the position
from Andrew Poppe, the lead before me, and have now passed the torch on to Marcus Piquette, the current SDC instrument lead.

Our job has been to maintain the health and safety of the instrument, to be responsible for operating it year in and year out, and perform the scientific analysis once the data is returned to the ground. Even as students, we also represented SDC at all the New Horizons team meetings and we were expected to present at the level of a professional scientist. What an invaluable experience it has been!

Not only has SDC pioneered a new kind of student involvement in a NASA mission, we’ve also been able to do some truly groundbreaking science. It turns out the solar system has a dust disk that extends out from near the sun all the way to the Kuiper Belt, and possibly beyond. Past Jupiter, this dust disk is comprised of material primarily shed from Kuiper Belt objects. Were an observer to be very far from our solar system, he or she wouldn’t see all the planets orbiting our sun—they would be too faint. Instead, an observer would see our solar system’s dust disk. The figure above shows a model of what our own solar system’s disk may look like.

As of late 2010, when it passed a distance of 18 AU (1.7 billion miles or 2.7 billion kilometers), SDC became the farthest reaching dust impact detector in history! SDC is bolted on the ‘windshield’ of New Horizons, so to speak, such that dust particles smash into it as the spacecraft transits the solar system. As SDC plunges through our dust disk, we’ve been able to measure and characterize the dust density distribution from Earth to Pluto, and beyond. With this information, not only can we better understand our solar system, but also help unravel the mysteries of countless other solar systems throughout the observable universe.

I’m very fortunate to have been involved with New Horizons in such a meaningful way by working on the Student Dust Counter team. Leading a student instrument for five years has truly been a unique experience, allowing me to understand the inner workings of a NASA deep space mission from the inside out. We’re thrilled to have reached Pluto and can’t wait to journey into the heart of the Kuiper Belt to learn what’s out there.

Source: NASA

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Zooming in on Pluto’s Pattern of Pits

On July 14 the telescopic camera on NASA’s New Horizons spacecraft took the highest resolution images ever obtained of the intricate pattern of “pits” across a section of Pluto’s prominent heart-shaped region, informally named Tombaugh Regio. Mission scientists believe these mysterious indentations may form through a combination of ice fracturing and evaporation. The scarcity of overlying impact craters in this area also leads scientists to conclude that these pits – typically hundreds of yards across and tens of yards deep – formed relatively recently. Their alignment provides clues about the ice flow and the exchange of nitrogen and other volatile materials between the surface and the atmosphere.

Source: NASA
3. Study Finds Evidence for More Recent Clay Formation on Mars

Clays and other minerals formed when rocks are altered by water have been found in multiple locations on Mars. It’s been assumed that these minerals probably formed in the earliest Martian epoch, over 3.7 billion years ago. But a new study finds that later clay formation might have been more common than many scientists thought.

Recent orbital and rover missions to Mars have turned up ample evidence of clays and other hydrated minerals formed when rocks are altered by the presence of water. Most of that alteration is thought to have happened during the earliest part of Martian history, more than 3.7 billion years ago. But a new study shows that later alteration — within the last 2 billion years or so — may be more common than many scientists had thought.

The research, by Brown University geologists Ralph Milliken and Vivian Sun, is in press in the Journal of Geophysical Research: Planets.

The lion’s share of the clay deposits found on Mars thus far have turned up in terrains that date back to the earliest Martian epoch, known as the Noachian period. Clays also tend to be found in and around large impact craters, where material from deep below the surface has been excavated. Scientists have generally assumed that the clays found at impact sites probably formed in the ancient Noachian, became buried over time, and then were brought back to the surface by the impact.

Latter day clay. Clay minerals in Martian impact craters have often been assumed to have been formed the planet's earliest epoch, then uncovered by the impact. New research finds numerous clay deposits that appear to have formed after an impact event, suggesting that clay formation on Mars was not confined to the planet's most ancient period.

Credit: NASA/JPL/University of Arizona/Brown University
That assumption is particularly true of clay deposits found in crater central peaks. Central peaks are formed when, in the aftermath of an impact, rocks from within the crust rebound upward, bringing layers to the surface that had been buried many kilometers deep.

“Because central peaks contain rocks uplifted from depth, some previous studies have assumed the clays found within central peak regions are uplifted too,” said Milliken, assistant professor of Earth, environmental and planetary sciences. “What we wanted to do was look at lots of these craters in detail to see if that’s actually correct.”

Milliken and Sun performed a survey of 633 crater central peaks distributed across the Martian surface. They looked at detailed mineralogy data collected by NASA’s Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), combined with high-resolution stereo images taken by NASA’s HiRISE camera. Both instruments fly aboard NASA’s Mars Reconnaissance Orbiter.

Of those 633 peaks, Milliken and Sun found 265 that have evidence of hydrated minerals, the majority of which were consistent with clays. The researchers then used HiRISE images to establish a detailed geologic context for each of those craters to help determine if the clays were in rocks that had indeed been excavated from depth. They found that in about 65 percent of cases the clay minerals were indeed associated with uplifted bedrock.

“That’s a majority,” Milliken said, “but it still leaves a substantial number of craters — 35 percent — where these minerals are present and not clearly associated with uplift.”

Within those 35 percent, Milliken and Sun found examples where clays exist in dunes, unconsolidated soil, or other formations not associated with bedrock. In other cases, clays were found in impact melt — deposits of rock that had been melted by the heat of the impact and then re-solidified as it cooled. Both of these scenarios suggest that the clay minerals at these sites are likely “authigenic,” meaning they formed in place sometime after impact occurred, rather than being excavated from underground.

In a number of cases, these authigenic clays were found in fairly young craters, ones formed in the last 2 billion years or so.

“What this tells us is that the formation of clays isn’t restricted to the most ancient time period on Mars,” Milliken said. “You do apparently have a lot of local environments in these crater settings where you can still form clays, and it may have occurred more often than many people had thought.”

One mechanism for forming these clays could be related to the impact process itself, the researchers say. Impacts generate heat, which could melt any ice or pre-existing hydrated minerals that may have been present within the nearby crust. Any liberated water could then percolate through surrounding rock to form clays. Some impact simulations suggest that these hydrothermal conditions could persist for perhaps thousands of years, making for potentially habitable conditions.

And that could have implications for the search for evidence of past life on Mars.

“So far, much of our surface exploration by rovers has focused on ancient terrains and whether or not the environments they record were habitable,” said Sun, lead author on the study and a graduate student working with Milliken. “But if we wanted to look at an environment that was more recent, we’ve identified craters that might be possible candidates.”

Source: Brown University / NASA
The Night Sky

**Tuesday, December 15**
- The waxing crescent Moon hangs in the southwest at nightfall. Look above it for the two brightest stars of Aquarius: Beta (β) and, higher, Alpha (α) Aquarii. Alpha is the bottom-right point of the Water Jar asterism.

**Wednesday, December 16**
- The Moon this evening stands midway between Fomalhaut, to its lower left, and Enif, the Nose of Pegasus, to its upper right. The Moon is about 20° from each.

**Thursday, December 17**
- The Moon shines more or less under the western (right) side of the Great Square of Pegasus at nightfall. Can you see the Moon moving with respect to this line as the hours go by?
- Algol should be at minimum brightness, magnitude 3.4 instead of its usual 2.1, for a couple of hours centered on 8:48 p.m. EST, according to revised predictions.

**Friday, December 18**
- First-quarter Moon (exact at 10:14 a.m. EST). This evening the Moon shines more or less under the eastern (left) side of the Great Square of Pegasus. Can you see the Moon moving with respect to this line as the hours go by?

Source: [Sky and Telescope](http://www.skyandtelescope.com)

Return to Contents
ISS Sighting Opportunities (from 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 Time Zone)

Tuesday, December 15

- 11:30 a.m. - ISS Expedition 46-47 Soyuz TMA-19M Docking Coverage (Docking scheduled at 12:24 p.m. ET) (Starts at 11:45 a.m.) (all channels)
- 1 p.m. - What’s New in Aerospace? Sewing Machines, Balloons, and Rocket Fuel: Developing the Next Generation of Mars Landing Technologies -- from the Smithsonian’s National Air & Space Museum (NTV-2 (Education))
- 2 p.m. - ISS Expedition 46-47 Soyuz TMA-19M Hatch Opening and Other Activities (Hatch Opening scheduled at 2:25 p.m. ET) (all channels)
- 4 p.m. - Video File of ISS Expedition 46-47 Soyuz TMA-19M Docking, Hatch Opening and Other Activities (all channels)

Wednesday, December 16

- 11:30 a.m. - ISS Expedition 46 Interviews with CBS “Face the Nation” and CNN International with ISS Commander Scott Kelly of NASA and Flight Engineer Mikhail Kornienko of the Russian Federal Space Agency (starts at 11:55 a.m.) (all channels)

Thursday, December 17

- 1 p.m. - The Smithsonian’s National Air and Space Museum Presents “STEM in 30” – The Wright Brothers (NTV-1 (Public), NTV-2 (Education))

Friday, December 18

- 9 a.m. - ISS Expedition 46 In-Flight Event for ESA with Flight Engineer Tim Peake and British Media (starts at 9:15 a.m.) (all channels)

Watch NASA TV online by going to the NASA website.
Space Calendar

- Dec 15 - Soyuz TMA-19M Soyuz-FG Launch (International Space Station 46S)
- Dec 15 - 50th Anniversary (1965), Gemini 6 Launch (Walter Schirra & Thomas Stafford)
- Dec 15 - Cassini, Orbital Trim Maneuver #433 (OTM-433)
- Dec 15 - Apollo Asteroid 2015 XY261 Near-Earth Flyby (0.002 AU)
- Dec 15 - Apollo Asteroid 2015 XN55 Near-Earth Flyby (0.006 AU)
- Dec 15 - Atira Asteroid 2013 JX28 Closest Approach To Earth (0.680 AU)
- Dec 15 - Asteroid 3115 Baily Closest Approach To Earth (1.241 AU)
- Dec 15 - Asteroid 42487 Angstrom Closest Approach To Earth (1.549 AU)
- Dec 15 - Apollo Asteroid 2212 Hephaistos Closest Approach To Earth (2.433 AU)
- Dec 15 - 50th Anniversary (1965), 1st Manned Spacecraft Rendezvous (Gemini 6 & 7)
- Dec 15 - Kin Endate's 55th Birthday (1960)
- Dec 16 - 50th Anniversary (1965), Pioneer 6 Launch (Sun Orbiter)
- Dec 16 - TeLEOS 1/PSLV Launch
- Dec 16 - Comet P/2014 W12 (Gibbs) Closest Approach To Earth (2.549 AU)
- Dec 16 - Comet 234P/LINEAR Closest Approach To Earth (2.777 AU)
- Dec 16 - Comet 314P/Montani At Opposition (3.535 AU)
- Dec 16 - Asteroid 2191 Uppsala Closest Approach To Earth (1.801 AU)
- Dec 16 - Plutino 55638 (2002 VE95) At Opposition (28.417 AU)
- Dec 16 - 50th Anniversary (1965), 1st Song Performed in Space (Gemini 6)
- Dec 17 - Galileo FM11 & FM12 Soyuz-STB Fregat-MT Launch
- Dec 17 - Cassini, Distant Flyby of Titan
- Dec 17 - Comet 81P/Wild At Opposition (1.538 AU)
- Dec 17 - Comet 196P/Tichy Closest Approach To Earth (1.676 AU)
- Dec 17 - Comet C/2015 T4 (PANSTARRS) Closest Approach To Earth (2.278 AU)
- Dec 17 - Comet C/2015 X4 (Elenin) Closest Approach To Earth (2.437 AU)
- Dec 17 - Apollo Asteroid 2015 XL261 Near-Earth Flyby (0.025 AU)
- Dec 17 - Asteroid 7749 Jackschmitt Closest Approach To Earth (1.870 AU)
- Dec 17 - 225th Anniversary (1790), Discovery of 24-Ton Aztec Sun Stone Calendar
- Dec 18 - Dark Matter Particle Explorer (DAMPE) CZ-2D Launch
- Dec 18 - Comet 94P/Russell Closest Approach To Earth (2.031 AU)
- Dec 18 - Comet 316P/LONEOS-Christensen Closest Approach To Earth (2.606 AU)
- Dec 18 - Apollo Asteroid 2015 MW53 Near-Earth Flyby (0.046 AU)
- Dec 18 - Aten Asteroid 2015 XX168 Near-Earth Flyby (0.047 AU)
- Dec 18 - Asteroid 5062 Glennmiller Closest Approach To Earth (1.037 AU)
- Dec 18 - Sir Joseph John Thomson's 160th Birthday (1856)

Source: JPL Space Calendar
Robots to Spy on Black Holes

Astronomers wanting more accurate measurements of distant black holes have some new assistants -- robots that can tackle the tedious task of monitoring black hole neighbor clouds’ glow.

The technique, known as reverberation mapping, has been in astronomers’ toolkits for decades, but it required much labor and telescope time.

The idea is that radiation from swirling matter at the mouth of an active black hole will light up distant clouds. By chemically analyzing the gas in the so-called accretion disk around the black hole and comparing it with the glow of gas farther away, astronomers can figure out the mass of the black hole and the strength of its gravitational field.

"This technique takes advantage of the fact that accretion disks don't always shine at the same brightness," the University of Texas McDonald Observatory wrote on its Stardate.org website.

"A disk can flare brightly as new material falls in ... or as magnetic fields cause some of the disk’s gas to clump together. Measuring how long it takes the surrounding clouds to brighten as they are illuminated by these flares reveals their distance from the black hole. And measuring the width of the lines in the spectra from these clouds reveals how fast they are moving," the observatory said.

To test whether a robot observatory could compile the maps, astronomers conducted a pilot program at the Las Cumbres Observatory Global Telescope Network (LCOGT), which currently consists of 11 automated telescopes in Texas, Hawaii, Australia, South Africa and Chile.

The network’s newest addition is FLOYDS, a pair of light-splitting spectrographs installed in the Faulkes Telescope North at Haleakala Observatory in Hawaii, and at the Faulkes Telescope South at Siding Spring Observatory in New South Wales, Australia.
"A spectrograph is a special kind of camera that splits the light of an object into its constituent colors, like a rainbow, and lets you do things like measure the chemical composition of an object and how fast it is moving with respect to you," astrophysicist David Sand, with Texas Tech University, wrote in an email to Discovery News.

Robotically taking pictures of the sky is pretty commonplace, he added, "but these spectrographs were – and still are – totally new."

(FLOYDS is named after the band Pink Floyd in honor of the iconic, light-splitting prism that graces the cover its "Dark Side of the Moon" record album.)

For about 200 days, the network’s robot imagers and the FLOYDS spectrograph in Hawaii kept tabs on Arp 151, a well-studied galaxy about 300 million light years away in the constellation Ursa Major, the Great Bear.

The galaxy contains a massive black hole, which previous reverberation mapping projects had determined to be between 6.5 million and 7 million times the mass of the sun. The Milky Way’s central black hole, by comparison, is about 4 million times the mass of the sun.

The robot astronomers proved capable, coming up with measurements that put Arp 151’s black hole mass at 6.2 million times the mass of the sun.

"It seems like the regions around the black hole had changed in the last few years, and that is very interesting," Sand said.

"These results represent the first step to demonstrate the powerful robotic capabilities of LCOGT for long-term (active galactic nuclei) campaigns that human intensive programs cannot easily accomplish," post-doctoral physics researcher Stefano Valenti, with the University of California at Santa Barbara, and colleagues conclude in a paper published last month in Astrophysical Journal Letters.

With a successful demonstration under its belt, the robot network is now turning its attention to a bigger survey of nearby and more distant galaxies with active black holes.

"We’re really going to try to push the technique into new regimes with our robotic capabilities," Sand said.

Source: [Space.com](http://www.space.com)
**Space Image of the Week**

![Image Credit: NASA, ESA, Hubble Space Telescope; Processing: Douglas Gardner](image)

**Arp 87: Merging Galaxies from Hubble**

**Image Credit:** NASA, ESA, Hubble Space Telescope; **Processing:** Douglas Gardner

**Explanation:** This dance is to the death. Along the way, as these two large galaxies duel, a cosmic bridge of stars, gas, and dust currently stretches over 75,000 light-years and joins them. The bridge itself is strong evidence that these two immense star systems have passed close to each other and experienced violent tides induced by mutual gravity. As further evidence, the face-on spiral galaxy on the right, also known as NGC 3808A, exhibits many young blue star clusters produced in a burst of star formation. The twisted edge-on spiral on the left (NGC 3808B) seems to be wrapped in the material bridging the galaxies and surrounded by a curious polar ring.

Together, the system is known as Arp 87 and morphologically classified, technically, as peculiar. While such interactions are drawn out over billions of years, repeated close passages should ultimately result in the death of one galaxy in the sense that only one galaxy will eventually result. Although this scenario does look peculiar, galactic mergers are thought to be common, with Arp 87 representing a stage in this inevitable process. The Arp 87 pair are about 300 million light-years distant toward the constellation Leo. The prominent edge-on spiral at the far left appears to be a more distant background galaxy and not involved in the on-going merger.

**Source:** [NASA APOD](https://apod.nasa.gov/apod/apod.html)