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Colorado School of Mines Geophysics Associate Professor Jeff Andrews-Hanna is the lead author of a study documenting the discovery of a giant rectangular structure (roughly 1,600 miles across) on the nearside of the Moon. Using NASA’s Gravity Recovery and Interior Laboratory (GRAIL) data, he is part of a team that examined the subsurface structure of the Procellarum region, also known as the Ocean of Storms. GRAIL scientists believe the Ocean of Storm's rocky outline is the result of ancient rift valleys, and not an asteroid impact as some previous theories suggested. The lava-flooded rift valleys are unlike anything found anywhere else on the Moon, and may at one time have resembled the rift zones on the Earth, Mars and Venus.

GRAIL gravity data is now allowing scientists to look beneath the surface at structures that are hidden from view, using the subtle gravitational pulls on the orbiting spacecraft. “This dataset has provided us with the highest resolution gravity map of any object in the solar system, including the Earth,” explained GRAIL principal investigator Maria Zuber from the Massachusetts Institute of Technology in Cambridge, Massachusetts.

Using the gradients in the gravity data to reveal the rectangular pattern of anomalies, the researchers can now clearly and completely see structures that were only hinted at by previous surface observations. This newly
discovered rectangular pattern has an area of approximately 6.5 million square kilometers (or 2.5 million square miles) and covers 17 percent of the surface of the Moon.

“This rectangular structure covers a larger fraction of the surface area of the Moon than do North America, Europe and Asia combined on the Earth,” Andrews-Hanna said. “This goes to show that there are still big discoveries waiting for us on all of the planets.”

The rectangular pattern with its angular corners and straight sides is at odds with the notion that Procellarum might be an ancient impact basin, as that hypothesis would predict a circular basin rim. Instead, the new work suggests that internally driven processes dominated the evolution of this region. In contrast, previous work by Andrews-Hanna and colleagues in 2008 used gravity data from Mars to reveal an enormous elliptical structure in the northern hemisphere of that planet, supporting the idea that the northern lowlands of Mars were formed by a giant impact that excavated the ‘Borealis Basin.’ Andrews-Hanna explains, “In two separate studies, we have used gravity data to support the existence of the largest impact basin in the solar system on Mars, and to refute the proposed second largest basin in the solar system on the Moon.”

"Our gravity data is opening up a new chapter of lunar history, during which the Moon was a more dynamic place than suggested by the cratered landscape that is visible to the naked eye," said Andrews-Hanna. More work is needed to understand the cause of this newfound pattern of gravity anomalies, and the implications for the history of the Moon.

GRAIL A and B, later renamed Ebb and Flow, were launched to the Moon in September 2011. The twin spacecraft flew in a nearly circular orbit until the end of the mission on Dec. 17, 2012. The gravity field was measured by tracking the changes in the distance between the spacecraft caused by perturbations to their orbit as they flew over anomalous masses caused by features on the surface or within the subsurface.

The GRAIL mission was managed by JPL, a division of the California Institute of Technology in Pasadena, Calif., for NASA's Science Mission Directorate in Washington. The mission was part of the Discovery Program managed at NASA's Marshall Space Flight Center in Huntsville, Ala. GRAIL was built by Lockheed Martin Space Systems in Denver.

Andrews-Hanna’s findings are published online in Nature. For more information about GRAIL, visit nasa.gov/grail and grail.nasa.gov.

The following organizations participated in this research: Colorado School of Mines; University of California, Santa Cruz; Brown University; Southwest Research Institute; Lunar and Planetary Institute; University of Hawaii; Purdue University; NASA Goddard Space Flight Center; Massachusetts Institute of Technology; Carnegie Institution of Washington; and Columbia University.

Source: Colorado School of Mines

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2. Delta IV Heavy Rocket Rolls to Launch Pad for Orion's First Flight Test

The United Launch Alliance (ULA) Delta IV Heavy rocket for Exploration Flight Test-1 rolled out of the Horizontal Integration Facility near Space Launch Complex 37 in the evening Sept. 30, and made the trek to the launch pad at Cape Canaveral Air Force Station in Florida. The rocket was carried to the launch complex by an Elevating Platform Transporter.

Early morning the next day, the nearly 180-foot-tall launch vehicle was carefully lifted into the vertical position using the Fixed Pad Erector and then raised into the Mobile Service Tower on the pad. “We’ve been working toward this launch for months, and we’re in the final stretch,” said Kennedy Space Center Director Bob Cabana. “Orion is almost complete and the rocket that will send it into space is on the launch pad. We’re 64 days away from taking the next step in deep-space exploration.”

About 15 ULA engineers, technicians, and representatives from safety, quality, security and other groups ensured that the launch vehicle arrived safely at the pad. “This is a tremendous milestone and gets us one step closer to our launch later this year,” said Tony Taliancich, ULA’s director of East Coast Launch Operations. “The team has worked extremely hard to ensure this vehicle is processed with the utmost attention to detail and focus on mission success.”

For this rollout, NASA’s Launch Services Program (LSP) participated in ULA’s Component Responsible Engineer Readiness Review in Denver, Colorado, and the Launch Vehicle On Stand Test Readiness Review at the ULA launch site. “We review launch site processing and preparations to make sure everything that is necessary to proceed with putting the rocket on the pad has been completed,” said Merri Anne Stowe, LSP Fleet Systems Integration Branch. “We serve in an advisory role for the EFT-1 mission. We're there to help only if issues come up.”
While the Delta IV waits on the launch pad, workers have been busy at several Kennedy facilities preparing the Orion spacecraft for its flight. On Sept. 11, the Lockheed Martin-built Orion spacecraft, attached to its service module, moved from the Operations and Checkout Building to the Payload Hazardous Servicing Facility. The spacecraft was fueled with ammonia, hydrazine and high-pressure helium ahead of its December flight test.

The spacecraft was moved to the Launch Abort System Facility on Sept. 28. Work currently is underway to install the Launch Abort System around Orion.

Orion's first flight test is scheduled for Dec. 4. During the mission, the spacecraft will travel 3,600 miles in altitude above the Earth and return home at speeds of 20,000 miles per hour. The spacecraft will endure temperatures near 4,000 degrees Fahrenheit. The flight's goals are to test many of the systems critical to Orion, including the heat shield, the launch abort system and the parachute system.

A team of NASA, Lockheed Martin and U.S. Navy workers, with coordination from the agency's Ground Systems Development and Operations Program, will retrieve Orion, the forward bay cover and the parachute system after splashdown in the Pacific Ocean.

An uncrewed Orion will launch atop NASA's Space Launch System on Exploration Mission 1. The spacecraft will serve as the exploration vehicle that will carry astronauts to space and provide safe re-entry from deep space missions.

"There has been a lot of excellent work done to get to this point and it's exciting to see the hardware coming together at the launch pad," Stowe said. "I'm looking forward to eventually seeing astronauts launched from Kennedy again."

Source: NASA
Scientists analyzing data from NASA's Cassini mission have discovered that a giant, toxic cloud is hovering over the south pole of Saturn's largest moon, Titan, after the atmosphere there cooled dramatically.

The scientists found that this giant polar vortex contains frozen particles of the toxic compound hydrogen cyanide, or HCN.

"The discovery suggests that the atmosphere of Titan's southern hemisphere is cooling much faster than we expected," said Remco de Kok of Leiden Observatory and SRON Netherlands Institute for Space Research, lead author of the study published today in the journal Nature.

Titan is the only moon in the solar system that is cloaked in a dense atmosphere. Like our home planet, Earth, Titan experiences seasons. As it makes its 29-year orbit around the sun along with Saturn, each season lasts about seven Earth years. The most recent seasonal switch occurred in 2009, when winter gave way to spring in the northern hemisphere, and summer transitioned to autumn in the southern hemisphere.

In May 2012, while Titan's southern hemisphere was experiencing autumn, images from Cassini revealed a huge swirling cloud, several hundred miles across, taking shape above Titan's south pole. This polar vortex appears to be an effect of the change of season.

A puzzling detail about the swirling cloud is its altitude, some 200 miles (about 300 kilometers) above Titan's surface, where scientists thought the temperature was too warm for clouds to form. "We really didn't expect to see such a massive cloud so high in the atmosphere," said de Kok.
Keen to understand what could give rise to this mysterious cloud, the scientists dove into Cassini's observations and found an important clue in the spectrum of sunlight reflected by Titan's atmosphere.

A spectrum splits the light from a celestial body into its constituent colors, revealing signatures of the elements and molecules present. Cassini's visual and infrared mapping spectrometer (VIMS) maps the distribution of chemical compounds in Titan's atmosphere and on its surface.

"The light coming from the polar vortex showed a remarkable difference with respect to other portions of Titan's atmosphere," says de Kok. "We could clearly see a signature of frozen HCN molecules."

As a gas, HCN is present in small amounts in the nitrogen-rich atmosphere of Titan. Finding these molecules in the form of ice was surprising, as HCN can condense to form frozen particles only if the atmospheric temperature is as cold as minus 234 degrees Fahrenheit (minus 148 degrees Celsius). This is about 200 degrees Fahrenheit (about 100 degrees Celsius) colder than predictions from current theoretical models of Titan's upper atmosphere.

To check whether such low temperatures were actually possible, the team looked at observations from Cassini's composite infrared spectrometer (CIRS), which measures atmospheric temperature at different altitudes. Those data showed that the southern hemisphere of Titan has been cooling rapidly, making it possible to reach the cold temperature needed to form the giant toxic cloud seen on the south pole.

Atmospheric circulation has been drawing large masses of gas towards the south since the change of season in 2009. As HCN gas becomes more concentrated there, its molecules shine brightly at infrared wavelengths, cooling the surrounding air in the process. Another factor contributing to this cooling is the reduced exposure to sunlight in Titan's southern hemisphere as winter approaches there.

"These fascinating results from a body whose seasons are measured in years rather than months provide yet another example of the longevity of the remarkable Cassini spacecraft and its instruments," said Earl Maize, Cassini project manager at NASA's Jet Propulsion Laboratory in Pasadena, California. "We look forward to further revelations as we approach summer solstice for the Saturn system in 2017."

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL, a division of the California Institute of Technology, Pasadena, manages the mission for NASA's Science Mission Directorate in Washington. The VIMS team is based at the University of Arizona in Tucson. The CIRS team is based at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

More information about Cassini is available at the following sites:


Source: Spaceref.com
The Night Sky

Friday, October 3

As evening twilight fades away, look very far to the lower left of the Moon for Fomalhaut, the Autumn Star, already on its way up from the southeast horizon.

Saturday, October 4

The W pattern of Cassiopeia stands vertically (on its dimmer end) high in the northeast around 10 or 11 p.m., depending on your location. By then the Big Dipper is lying level just above the north-northwest horizon — if you live in the mid-northern latitudes. As far south as San Diego and Jacksonville, the Dipper will lie partly below the horizon.

Sunday, October 5

Look above the gibbous Moon this evening for the Water Jar asterism of Aquarius. It's not bright; you may need binoculars.

Monday, October 6

As twilight fades, look for Arcturus, the Spring Star, twinkling in the west to west-northwest. It's still pretty easy to see. But how much later into the fall, as it sinks away, will you be able to keep it in view?

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](https://www.nasa.gov/mission_pages/space-station/iss-tracking/)

NASA-TV Highlights
(all times Eastern Daylight Time)

**Friday, October 3**
2 p.m., ISS Expedition 41 U.S. Spacewalk Briefing (all channels)

**Tuesday, October 7**
7 a.m., Coverage of the ISS Expedition 41 U.S. Spacewalk # 27 (Wiseman and Gerst; spacewalk scheduled to begin at 8:10 a.m. ET) (all channels)

Watch NASA TV on the Net by going to the [NASA website](https).

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Space Calendar

- Oct 03 - Comet 308P/Lagerkvist-Carsenty At Opposition (3.365 AU)
- Oct 03 - Asteroid 2014 SX261 Near-Earth Flyby (0.023 AU)
- Oct 03 - Asteroid 2011 PT Near-Earth Flyby (0.045 AU)
- Oct 03 - [Sep 28] Asteroid 2014 SU261 Near-Earth Flyby (0.056 AU)
- Oct 03 - Asteroid 217628 Lugh Closest Approach To Earth (1.084 AU)
- Oct 03 - Asteroid 12711 Tukmit Closest Approach To Earth (1.260 AU)
- Oct 03 - Asteroid 4766 Malin Closest Approach To Earth (1.586 AU)
- Oct 03 - Asteroid 9661 Hohmann Closest Approach To Earth (2.110 AU)
- Oct 04 - [Sep 27] Astronomy Day
- Oct 04 - [Sep 27] Comet P/2014 S4 (Gibbs) At Opposition (1.436 AU)
- Oct 04 - Comet 170P/Christensen Closest Approach To Earth (1.936 AU)
- Oct 04 - Comet 286P/Christensen Closest Approach To Earth (2.109 AU)
- Oct 04 - Comet P/2008 Y2 (Gibbs) At Opposition (2.555 AU)
- Oct 04 - Comet 211P/Hill At Opposition (2.627 AU)
- Oct 04 - Asteroid 2012 HN1 Near-Earth Flyby (0.086 AU)
- Oct 04 - Asteroid 5799 Brewington Closest Approach To Earth (1.208 AU)
- Oct 04 - 10th Anniversary (2004), SpaceShipOne Launch F-3 (3rd Private Manned Space Flight)
- Oct 04 - 55th Anniversary (1959), Luna 3 Launch (USSR Moon Flyby Mission)
- Oct 04 - 55th Anniversary (1959), Little Joe 1 Launch
- Oct 04-10 - [Sep 27] World Space Week
- Oct 05 - Comet 210P/Christensen At Opposition (2.055 AU)
- Oct 05 - Comet P/2009 WX51 (Catalina) At Opposition (2.101 AU)
- Oct 05 - Comet 235P/LINEAR At Opposition (4.186 AU)
- Oct 05 - [Oct 02] Asteroid 2014 Sf304 Near-Earth Flyby (0.005 AU)
- Oct 05 - Asteroid 589 Croatia Closest Approach To Earth (2.026 AU)
- Oct 05 - Asteroid 274860 Emilylakdawalla Closest Approach To Earth (2.085 AU)
- Oct 05 - Richard Gordon’s 85th Birthday (1929)
- Oct 06 - Comet 170P/Christensen At Opposition (1.936 AU)
- Oct 06 - Comet 308P/Lagerkvist-Carsenty Closest Approach To Earth (3.364 AU)
- Oct 06 - [Sep 25] Asteroid 2014 SB145 Near-Earth Flyby (0.011 AU)
- Oct 06 - Asteroid 2012 U136 Near-Earth Flyby (0.100 AU)
- Oct 06 - Asteroid 9258 Johnpauliones Closest Approach To Earth (0.960 AU)
- Oct 06 - Asteroid 582 Olympia Closest Approach To Earth (1.594 AU)
- Oct 06 - Asteroid 2157 Ashbrook Closest Approach To Earth (1.926 AU)
- Oct 06 - [Sep 27] Science Discussion Meeting: THE@INT - A Terra Hunting Experiment and a New High Resolution Spectrograph for the Isaac Newton Telescope, London, United Kingdom
- Oct 06 - 10th Anniversary (2004), Cassini, 1st Targeted Titan Flyby

Source: JPL Space Calendar
Food for Thought

Mars Rover Technology Adapted to Detect Gas Leaks

In collaboration with NASA’s Jet Propulsion Laboratory in Pasadena, California, Pacific Gas and Electric Company (PG&E) announced that it is testing state-of-the-art technology adapted from NASA’s Mars rover program. Originally designed to find methane on the Red Planet, this laser-based technology is lightweight and has superior sensitivity to methane, a major component of natural gas. The technology applied back on Earth helps guide PG&E crews using a tablet interface to identify possible leak locations, fast-tracking their ability to repair gas leaks.

“Our pursuit of this technology is evidence of our commitment to our mission of becoming the safest, most reliable utility in the country. We are using out-of-this-world technology to find and fix even the smallest leaks in our system. By investing in innovation today, we are helping build a positive energy future,” said Nick Stavropoulos, PG&E’s executive vice president of gas operations.

On Sept. 29, a new law, SB 1371, required the California Public Utilities Commission (CPUC) to open a proceeding to adopt rules and procedures that minimize natural gas leaks from gas pipelines, with the goal of reducing emissions of greenhouse gases, such as methane.

The hand-held device is the latest piece of advanced leak detection technology being embraced by the utility and is expected to be available for use in 2015. The development of this tool is part of a collaborative research effort at Pipeline Research Council International (PRCI).

“It’s rewarding to be involved in projects that translate JPL technological capabilities to meet industry needs, technologies which ultimately should help enhance safety and reliability. PG&E’s role as a collaborator with JPL on our PRCI-funded effort is essential to efficiently adapt the JPL methane sensor into a field-ready hand-held leak detection system,” said Andrew Aubrey, JPL technologist.

Pacific Gas and Electric Company, a subsidiary of PG&E Corporation (NYSE:PCG), is one of the largest combined natural gas and electric utilities in the United States. Based in San Francisco, with more than 20,000 employees, the company delivers some of the nation’s cleanest energy to nearly 16 million people in Northern and Central California. For more information, visit www.pge.com/ and http://www.pge.com/about/newsroom/.

NASA’s Jet Propulsion Laboratory is managed by the California Institute of Technology in Pasadena.

Source: NASA
Aurora and Milky Way in a Little Sky

Explanation:  Stepping stones seem to lead to the Milky Way as it stretches across this little sky. Of course, the scene is really the northern hemisphere's autumnal equinox night. Water and sky are inverted by a top to bottom, around the horizon stereographic projection centered on the zenith above Lake Storsjön in Jämtland, Sweden. In the north the Milky Way arcs from east to west overhead as fall begins, but the season is also a good time for viewing aurora. Geomagnetic storms increase in frequency near the equinox and produce remarkable displays of northern lights at high latitudes, like the eerie greenish glow reflected in this watery cosmos.

Image Credit & Copyright: Göran Strand

Source: Astronomy Picture of the Day