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Pluto’s largest moon may have gotten too big for its own skin.

Images from NASA’s New Horizons mission suggest that Pluto’s moon Charon once had a subsurface ocean that has long since frozen and expanded, pushing outward and causing the moon’s surface to stretch and fracture on a massive scale.

The side of Pluto’s largest moon viewed by NASA’s passing New Horizons spacecraft in July 2015 is characterized by a system of “pull apart” tectonic faults, which are expressed as ridges, scarps and valleys—the latter sometimes reaching more than 4 miles (6.5 kilometers) deep. Charon’s tectonic landscape shows that, somehow, the moon expanded in its past, and – like Bruce Banner tearing his shirt as he becomes the Incredible Hulk – Charon’s surface fractured as it stretched.

The outer layer of Charon is primarily water ice. This layer was kept warm when Charon was young by heat provided by the decay of radioactive elements, as well as Charon’s own internal heat of formation. Scientists say Charon could have been warm enough to cause the water ice to melt deep down, creating a subsurface ocean. But as Charon cooled over time, this ocean would have frozen and expanded (as happens when water freezes), lifting the outermost layers of the moon and producing the massive chasms we see today.

The top portion of this image shows part of the feature informally named Serenity Chasma, part of a vast equatorial belt of chasms on Charon. In fact, this system of chasms is one of the longest seen anywhere in the solar system, running at least 1,100 miles (about 1,800 kilometers) long and reaching 4.5 miles (7.5 kilometers) deep. By comparison, the Grand Canyon is 277 miles (446 kilometers) long and just over a mile (1.6 kilometers) deep.

The lower portion of the image shows color-coded topography of the same scene. Measurements of the shape of this feature tell scientists that Charon’s water ice layer may have been at least partially liquid in its early history, and has since refrozen.
This image was obtained by the Long-Range Reconnaissance Imager (LORRI) on New Horizons. North is up; illumination is from the top-left of the image. The image resolution is about 1,290 feet (394 meters) per pixel. The image measures 240 miles (386 kilometers) long and 110 miles (175 kilometers) wide. It was obtained at a range of approximately 48,900 miles (78,700 kilometers) from Charon, about an hour and 40 minutes before New Horizons’ closest approach to Charon on July 14, 2015.

Source: NASA
2. Test Cubes Floating Freely Inside LISA Pathfinder

ESA’s LISA Pathfinder has released both of its gold–platinum cubes, and will shortly begin its demanding science mission, placing these test masses in the most precise freefall ever obtained to demonstrate technologies for observing gravitational waves from space.

Launched on 3 December, LISA Pathfinder reached its operational location on 22 January, some 1.5 million km from Earth in the direction of the Sun.

As tests on the spacecraft and its precious payload continue, a major milestone was reached today. For the first time, the two masses – a pair of identical 46 mm gold–platinum cubes – in the heart of the spacecraft are floating freely, several millimetres from the walls of their housings. The cubes sit 38 cm apart linked only by laser beams.

Throughout LISA Pathfinder’s ground handling, launch, the burns that raised its orbit, and the six-week cruise to its work site, each cube was held firmly in place by eight ‘fingers’ pressing on its corners.

On 3 February, the locking fingers were retracted and a valve was opened to allow any residual gas molecules around the cubes to vent to space. Each cube remained in the centre of its housing held by a pair of rods softly pushing on two opposite sides. The rods were finally released from one test mass yesterday and from the other today, leaving the cubes floating freely, with no mechanical contact with the spacecraft.

“This is why we sent the test cubes into space: to recreate conditions that are impossible to achieve in the gravitational field of our planet,” says Paul McNamara, ESA’s project scientist. “Only under these conditions is it possible to test freefall in the purest achievable form. We can’t wait to start running experiments with this amazing gravity laboratory.”

It will be another week before the cubes are left completely at the mercy of gravity, with no other forces acting on them. Before then, minute electrostatic forces are being applied to move them around and make them follow the spacecraft as its flight through space is slightly perturbed by outside forces such as pressure from sunlight.
On 23 February, the team will switch LISA Pathfinder to science mode for the first time, and the opposite will become true: the cubes will be in freefall and the spacecraft will start sensing any motions towards them owing to external forces. Microthrusters will make minuscule shifts in order to keep the craft centred on one mass.

Then the scientists will be in a position to run several months of experiments to determine how accurately the two freely-flying test masses can be kept positioned relative to each other, making measurements with the laser that links them. Roughly speaking, the required accuracy is on the order of a millionth of a millionth of a metre.

Source: ESA
3. Hubble Directly Measures Rotation of Cloudy 'Super-Jupiter'

Astronomers using NASA's Hubble Space Telescope have measured the rotation rate of an extreme exoplanet by observing the varied brightness in its atmosphere. This is the first measurement of the rotation of a massive exoplanet using direct imaging.

"The result is very exciting," said Daniel Apai of the University of Arizona in Tucson, leader of the Hubble investigation. "It gives us a unique technique to explore the atmospheres of exoplanets and to measure their rotation rates."

The planet, called 2M1207b, is about four times more massive than Jupiter and is dubbed a "super-Jupiter." It is a companion to a failed star known as a brown dwarf, orbiting the object at a distance of 5 billion miles. By contrast, Jupiter is approximately 500 million miles from the sun. The brown dwarf is known as 2M1207. The system resides 170 light-years away from Earth.

Hubble's image stability, high resolution, and high-contrast imaging capabilities allowed astronomers to precisely measure the planet's brightness changes as it spins. The researchers attribute the brightness variation to complex clouds patterns in the planet's atmosphere. The new Hubble measurements not only verify the presence of these clouds, but also show that the cloud layers are patchy and colorless.

Astronomers first observed the massive exoplanet 10 years ago with Hubble. The observations revealed that the exoplanet's atmosphere is hot enough to have "rain" clouds made of silicates: vaporized rock that cools down to form tiny particles with sizes similar to those in cigarette smoke. Deeper into the atmosphere, iron droplets are forming and falling like rain, eventually evaporating as they enter the lower levels of the atmosphere.

"So at higher altitudes it rains glass, and at lower altitudes it rains iron," said Yifan Zhou of the University of Arizona, lead author on the research paper. "The atmospheric temperatures are between about 2,200 to 2,600 degrees Fahrenheit."

The super-Jupiter is so hot that it appears brightest in infrared light. Astronomers used Hubble's Wide Field Camera 3 to analyze the exoplanet in infrared light to explore the object's cloud cover and measure its rotation rate. The planet is hot because it is only about 10 million years old and is still contracting and cooling. For comparison, Jupiter in our solar system is about 4.5 billion years old.

The planet, however, will not maintain these sizzling temperatures. Over the next few billion years, the object will cool and fade dramatically. As its temperature decreases, the iron and silicate clouds will also form lower and lower in the atmosphere and will eventually disappear from view.

Zhou and his team have also determined that the super-Jupiter completes one rotation approximately every 10 hours, spinning at about the same fast rate as Jupiter.
This super-Jupiter is only about five to seven times less massive than its brown-dwarf host. By contrast, our sun is about 1,000 times more massive than Jupiter. "So this is a very good clue that the 2M1207 system we studied formed differently than our own solar system," Zhou explained. The planets orbiting our sun formed inside a circumstellar disk through accretion. But the super-Jupiter and its companion may have formed throughout the gravitational collapse of a pair of separate disks.

"Our study demonstrates that Hubble and its successor, NASA's James Webb Space Telescope, will be able to derive cloud maps for exoplanets, based on the light we receive from them," Apai said. Indeed, this super-Jupiter is an ideal target for the Webb telescope, an infrared space observatory scheduled to launch in 2018. Webb will help astronomers better determine the exoplanet's atmospheric composition and derive detailed maps from brightness changes with the new technique demonstrated with the Hubble observations.

Results from this study will appear in the Feb. 11, 2016, edition of The Astrophysical Journal.

For more information about NASA's Hubble Space Telescope, visit www.nasa.gov/hubble.

Source: NASA
The Night Sky

Friday, February 19

• This evening the waxing gibbous Moon shines below Castor and Pollux. They don't quite point to it... yet. Keep an eye on them as you stay up late. The Moon creeps ever eastward against the stars, and very late tonight (for North America) it aligns with Castor and Pollux perfectly.

Saturday, February 20

• Capella crosses highest overhead, and Rigel stands highest in the south, around 7 or 8 p.m. now depending on where you live east or west in your time zone. Capella is at declination +46°, so it passes exactly through your zenith if you’re at latitude 46° north: Portland, Oregon; Montreal; northern Italy. Another, slightly lesser star-pair also transits the meridian in tandem just ten minutes later: Bellatrix (Gamma Orionis) and El Nath (Beta Tauri).

Sunday, February 21

• The bright Moon, not quite full, shines near Regulus all night. • Algol should shine at its minimum brightness, magnitude 3.4 instead of its usual 2.1, for a couple hours centered on 7:39 p.m. EST.

Monday, February 22

• Full Moon (exact at 1:20 p.m. EST). Look above the Moon by about a fist at arm's length for Regulus.

Tuesday, February 23

• The Moon and Jupiter shine together after they rise around the end of twilight tonight. Although they appear paired, Jupiter is currently 1,700 times farther away. P.S: It's 40 times larger in diameter.

Use binoculars to spot some of Jupiter's own four big moons; the easiest will be Callisto to the planet's east. They're pinpoints in binocs but roughly as big as our own Moon in reality.

Watch the Moon pull away eastward from Jupiter through the rest of the night.

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)

Wednesday, February 24
11 a.m., ISS Expedition 46 Round-Robin Interviews for U.S. Television Networks with Commander Scott Kelly of NASA (preempts Space Station Live) (starts at 11:10 a.m.) (all channels)

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

- Feb 19 - [Cassini](#), Orbital Trim Maneuver #443 (OTM-443)
- Feb 19 - [Apollo Asteroid 2016 CD137](#) Near-Earth Flyby (0.017 AU)
- Feb 19 - [Asteroid 11341 Babbage](#) Closest Approach To Earth (1.282 AU)
- Feb 19 - [Asteroid 6143 Pythagoras](#) Closest Approach To Earth (2.065 AU)
- Feb 19 - 60th Anniversary (1956), [Sinnai Meteorite](#) Fall (Hit Hut in Italy)
- Feb 19 - 220th Anniversary (1796), [Portugal Meteorite](#) Fall
- Feb 19 - 460th Anniversary (1556), [Great Comet of 1556](#) 1st Observed
- Feb 19 - [Cygnus Reentry into Earth's Atmosphere](#)
- Feb 19 - [Comet P/2008 WZ96 (LINEAR) At Opposition](#) (2.147 AU)
- Feb 19 - [Apollo Asteroid 2016 CO29](#) Near-Earth Flyby (0.040 AU)
- Feb 19 - [Apollo Asteroid 12923 Zephyr Closest Approach To Earth](#) (1.947 AU)
- Feb 19 - [Asteroid 8000 Isaac Newton](#) Closest Approach To Earth (2.329 AU)
- Feb 19 - [Kuiper Belt Object 148209 (2000 CR105) At Opposition](#) (59.536 AU)
- Feb 19 - British Interplanetary Society (BIS) West Midland Event, Worcs, United Kingdom
- Feb 19 - 20th Anniversary (1996), Yukio Sakurai's Discovery of [Sakurai's Object (V4334 Sgr)](#)
- Feb 19 - 30th Anniversary (1986), [Mir Space Station](#) Launch
- Feb 19 - Joseph Walker's 95th Birthday (1921)
- Feb 20 - [Comet 73P-AA/Schwassmann-Wachmann At Opposition](#) (1.446 AU)
- Feb 20 - [Asteroid 2852 Declercq Occults HIP 46232> (6.3 Magnitude Star)](#)
- Feb 20 - [Asteroid 14764 Kilaeua](#) Closest Approach To Earth (0.894 AU)
- Feb 20 - [Asteroid 19204 Joshua Tree](#) Closest Approach To Earth (1.381 AU)
- Feb 20 - [Asteroid 25924 Douglas Adams](#) Closest Approach To Earth (1.536 AU)
- Feb 20 - [Asteroid 78756 Sloan](#) Closest Approach To Earth (2.134 AU)
- Feb 20 - [Asteroid 10044 Squyes](#) Closest Approach To Earth (2.379 AU)
- Feb 20 - [Asteroid 4226 Damaia](#) Closest Approach To Earth (2.594 AU)
- Feb 20 - [Apollo Asteroid 2329 Orthos Closest Approach To Earth](#) (2.924 AU)
- Feb 20 - [Comet C/2013 G9 (Tenagra) At Opposition](#) (5.279 AU)
- Feb 20 - [Aten Asteroid 2010 WD1 Near-Earth Flyby](#) (0.032 AU)
- Feb 20 - [Asteroid 163693 Atira Closest Approach To Earth](#) (1.361 AU)
- Feb 20 - [Asteroid 9499 Excalibur](#) Closest Approach To Earth (1.936 AU)
- Feb 20 - [Asteroid 100007 Peters](#) Closest Approach To Earth (2.191 AU)
- Feb 20 - 20th Anniversary (1996), [STS-75 Launch](#) (Space Shuttle Columbia)
- Feb 20 - 30th Anniversary (1986), [Sweden's 1st Satellite Launch (Viking)](#)
- Feb 20 - 60th Anniversary (1966), [Kosmos 110 Launch](#) (Carried Two Dogs: Veterok & Ugolyok)
- Feb 20 - 110th Anniversary (1906), Max Wolf's Discovery of the [1st Trojan Asteroid (588 Achilles)](#)

![Joseph Walker in 1961](image)

Source: JPL Space Calendar

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Food for Thought

NASA Invites Public to Send Artwork to an Asteroid

NASA is calling all space enthusiasts to send their artistic endeavors on a journey aboard NASA’s Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) spacecraft. This will be the first U.S. mission to collect a sample of an asteroid and return it to Earth for study.

OSIRIS-REx is scheduled to launch in September and travel to the asteroid Bennu. The #WeTheExplorers campaign invites the public to take part in this mission by expressing, through art, how the mission’s spirit of exploration is reflected in their own lives. Submitted works of art will be saved on a chip on the spacecraft. The spacecraft already carries a chip with more than 442,000 names submitted through the 2014 “Messages to Bennu” campaign.

“The development of the spacecraft and instruments has been a hugely creative process, where ultimately the canvas is the machined metal and composites preparing for launch in September,” said Jason Dworkin, OSIRIS-REx project scientist at NASA’s Goddard Space Flight Center in Greenbelt, Maryland. “It is fitting that this endeavor can inspire the public to express their creativity to be carried by OSIRIS-REx into space.”

A submission may take the form of a sketch, photograph, graphic, poem, song, short video or other creative or artistic expression that reflects what it means to be an explorer. Submissions will be accepted via Twitter and Instagram until March 20. For details on how to include your submission on the mission to Bennu, go to:

http://www.asteroidmission.org/WeTheExplorers

“Space exploration is an inherently creative activity,” said Dante Lauretta, principal investigator for OSIRIS-REx at the University of Arizona, Tucson. “We are inviting the world to join us on this great adventure by placing their art work on the OSIRIS-REx spacecraft, where it will stay in space for millennia.”

The spacecraft will voyage to the near-Earth asteroid Bennu to collect a sample of at least 60 grams (2.1 ounces) and return it to Earth for study. Scientists expect Bennu may hold clues to the origin of the solar system and the source of the water and organic molecules that may have made their way to Earth.

Goddard provides overall mission management, systems engineering and safety and mission assurance for OSIRIS-REx. The University of Arizona, Tucson leads the science team and observation planning and processing. Lockheed Martin Space Systems in Denver is building the spacecraft. OSIRIS-REx is the third mission in NASA’s New Frontiers Program. NASA’s Marshall Space Flight Center in Huntsville, Alabama, manages New Frontiers for the agency’s Science Mission Directorate in Washington. For more information on OSIRIS-REx, visit http://www.nasa.gov/osiris-rex.

Source: NASA
Space Image of the Week

Milky Way over the Pinnacles in Australia

**Explanation:** What strange world is this? Earth. In the foreground of the featured image are the Pinnacles, unusual rock spires in Nambung National Park in Western Australia. Made of ancient sea shells (limestone), how these human-sized picturesque spires formed remains unknown. In the background, just past the end of the central Pinnacle, is a bright crescent Moon. The eerie glow around the Moon is mostly zodiacal light, sunlight reflected by dust grains orbiting between the planets in the Solar System. Arching across the top is the central band of our Milky Way Galaxy. Many famous stars and nebula are also visible in the background night sky. The featured 29-panel panorama was taken and composed last September after detailed planning that involved the Moon, the rock spires, and their corresponding shadows. Even so, the strong zodiacal light was a pleasant surprise.

**Image Credit:** Michael Goh

Source: Astronomy Picture of the Day

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