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1. Odd 'Dark Hydrogen' May Lurk Within Jupiter, Other Giant Planets

Exotic "dark hydrogen" lurks within giant planets such as Saturn and Jupiter, a new study suggests.

This strange form of hydrogen likely lies between the gaseous hydrogen in the clouds of gas giants such as Saturn and Jupiter and the liquid-metal hydrogen found in these planets' cores, according to the study.

"This dark hydrogen layer was unexpected and inconsistent with what modeling research had led us to believe about the change from hydrogen gas to metallic hydrogen inside of celestial objects," author Alexander Goncharov, a physicist at the Carnegie Institution for Science in Washington, D.C., said in a statement.

Goncharov and his colleagues used a laser-heated "diamond anvil cell" to create the conditions likely to be found inside gas giants. Probing hydrogen under pressures ranging from 10,000 to 1.5 million times that found in Earth's atmosphere, and through temperatures as high as 10,000 degrees Fahrenheit (5,500 degrees Celsius), they discovered an intermediate phase of the element.

Jupiter, Saturn, Neptune and Uranus all have gaseous hydrogen atmospheres that extend all the way to their mantles. A layer of liquid metal hydrogen lies within their cores. Dark hydrogen may separate the boundary in between, the researchers said.

Dark hydrogen is so named because it doesn't transmit or reflect visible light. However, the stuff does transmit infrared radiation.

"This observation would explain how heat can easily escape from gas giants like Saturn," Goncharov said.

Dark hydrogen is slightly metallic and can conduct an electric current (though not as well as liquid-metal hydrogen does). The material likely plays a role in creating magnetic fields around the planets of the outer solar system, the researchers said.

The research, which was led by R. Stewart McWilliams of the Carnegie Institution, Edinburgh University in Scotland and Howard University in Washington, D.C, was published last week in the journal Physical Review Letters.

Source: Space.com
High concentrations of manganese oxides found in Martian rocks by NASA’s Curiosity rover indicate the red planet’s atmosphere once had much more oxygen than previously thought, scientists said Monday.

Geologists scrutinizing data from Curiosity’s ChemCam instrument, which takes remote measurements of rocks with a laser, discovered the manganese oxides in mineral veins, or cracks, embedded in sandstones at a research site named “Windjana” the rover visited in 2014.
Windjana is one of many geological sites studied by Curiosity since its landing in Gale Crater in August 2012.

Researchers already believed the vein-like features come from minerals left behind by water, and the presence of manganese oxides — chemicals that must have formed in an oxygen-rich atmosphere — seemingly ties the ancient wet environment to a time billions of years ago when more oxygen was in the air.

“The only ways on Earth that we know how to make these manganese materials involve atmospheric oxygen or microbes,” said Nina Lanza, a planetary scientist at Los Alamos National Laboratory in New Mexico, which led development of Curiosity’s ChemCam instrument. “Now we’re seeing manganese oxides on Mars, and we’re wondering how the heck these could have formed?”

The atmospheric oxygen explanation for the manganese oxides is more plausible than a biological origin, scientists said in an announcement Monday accompanying the finding’s publication in the journal Geophysical Research Papers.

“These high manganese materials can’t form without lots of liquid water and strongly oxidizing conditions,” Lanza said in a statement issued by the the Los Alamos National Laboratory. “Here on Earth, we had lots of water but no widespread deposits of manganese oxides until after the oxygen levels in our atmosphere rose due to photosynthesizing microbes.”

Scientists are still struggling to explain how the atmosphere of ancient Mars may have been enriched with oxygen, but one theory is it came from the water on the planet’s surface, NASA said in a press release.

“One potential way that oxygen could have gotten into the Martian atmosphere is from the breakdown of water when Mars was losing its magnetic field,” said Lanza, the lead author of a paper outlining the results in Geophysical Research Letters. “It’s thought that at this time in Mars’ history, water was much more abundant.”

As the Martian magnetic field eroded, cosmic and solar radiation penetrated to the planet’s surface, destroying water molecules and splitting them into hydrogen and oxygen. The lighter hydrogen atoms escaped into space, but the heavier oxygen atoms were trapped by Mars’ gravity, becoming embedded in rocks, scientists said.

That is what gives Mars its characteristic rust color. But manganese oxides need more oxygen to form than the widespread red iron oxides.

In a joint statement released by NASA and LANL, Lanza added that it is hard to determine exactly how the Martian atmosphere might have got its oxygen.

“But it’s important to note that this idea represents a departure in our understanding for how planetary atmospheres might become oxygenated,” Lanza said.

“Abundant atmospheric oxygen has been treated as a so-called biosignature, or a sign of extant life, but this process does not require life,” the joint statement said.

The manganese deposits are not limited to the Curiosity rover’s exploration zone in Gale Crater. NASA’s long-lived Opportunity rover recently discovered similar material in Meridiani Planum on the other side of Mars.

Source: Spaceflight Now
A booster for the most powerful rocket in the world, NASA's Space Launch System (SLS), successfully fired up Tuesday for its second qualification ground test at Orbital ATK's test facilities in Promontory, Utah. This was the last full-scale test for the booster before SLS’s first uncrewed test flight with NASA’s Orion spacecraft in late 2018, a key milestone on the agency's Journey to Mars.

“This final qualification test of the booster system shows real progress in the development of the Space Launch System,” said William Gerstenmaier, associate administrator for the Human Exploration and Operations Mission Directorate at NASA Headquarters in Washington. “Seeing this test today, and experiencing the sound and feel of approximately 3.6 million pounds of thrust, helps us appreciate the progress we’re making to advance human exploration and open new frontiers for science and technology missions in deep space.”

The booster was tested at a cold motor conditioning target of 40 degrees Fahrenheit – the colder end of its accepted propellant temperature range. When ignited, temperatures inside the booster reached nearly 6,000 degrees. The two-minute, full-duration ground qualification test provided NASA with critical data on 82 qualification objectives that will support certification of the booster for flight. Engineers now will evaluate these data, captured by more than 530 instrumentation channels on the booster.

When completed, two five-segment boosters and four RS-25 main engines will power SLS on deep space missions. The solid rocket boosters, built by NASA contractor Orbital ATK, operate in parallel with SLS’s main engines for the first two minutes of flight. They will provide more than 75 percent of the thrust needed for the rocket and Orion spacecraft to escape Earth’s gravitational pull.
"Today's test is the pinnacle of years of hard work by the NASA team, Orbital ATK and commercial partners across the country," said John Honeycutt, SLS Program manager at NASA's Marshall Space Flight Center in Huntsville, Alabama. “SLS hardware is currently in production for every part of the rocket. NASA also is making progress every day on Orion and the ground systems to support a launch from Kennedy Space Center in Florida. We're on track to launch SLS on its first flight test with Orion and pave the way for a human presence in deep space."

The first full-scale booster qualification ground test was successfully completed in March 2015 and demonstrated acceptable performance of the booster design at 90 degrees Fahrenheit – the highest end of the booster's accepted propellant temperature range. Testing at the thermal extremes experienced by the booster on the launch pad is important to understand the effect of temperature on how the propellant burns.

The initial SLS configuration will have a minimum 70-metric-ton (77-ton) lift capability. The next planned upgrade of SLS will use a powerful exploration upper stage for more ambitious missions, with a 105-metric-ton (115-ton) lift capacity. In each configuration, SLS will continue to use the same core stage and four RS-25 engines.

For more information about NASA's Journey to Mars, visit: [http://www.nasa.gov/journeytomars](http://www.nasa.gov/journeytomars)

Source: [NASA](http://www.nasa.gov)
The Night Sky

**Tuesday, June 28**

- Arcturus is the brightest star high in the west. Equally bright Vega is similarly high in the east. A third of the way from Arcturus to Vega, look for dim Corona Borealis, the Northern Crown, with its one modestly bright star, Gemma or Alphecca. Two thirds of the way, you'll find the dim Keystone of Hercules.

**Wednesday, June 29**

- As evening grows late, even the lowest star of the Summer Triangle climbs fairly high in the east. That would be Altair, a good three or four fists at arm's length below or lower right of bright Vega.

  Look left of Altair, by hardly more than one fist, for the compact little constellation Delphinus, the Dolphin.

**Thursday, June 30**

- Vega is the brightest star very high in the east. Barely to its lower left after dark is one of the best-known multiple stars in the sky: 4th-magnitude Epsilon ($\varepsilon$) Lyrae, the Double-Double. It forms one corner of a roughly equilateral triangle with Vega and Zeta ($\zeta$) Lyrae. The triangle is less than 2° on a side, hardly the width of your thumb at arm's length.

  Binoculars easily resolve Epsilon, and a 4-inch telescope at 100x or more should resolve each of Epsilon's wide components into a tight pair.

  Zeta Lyrae is also a double star for binoculars; much tougher, but easily split with any telescope. Delta ($\delta$) Lyrae, below Zeta, is much wider and easier.

- Mars is stationary; it ceases its retrograde (westward) motion and will begin returning eastward toward Saturn and Antares. It will slingshot between them on August 23rd and 24th.

**Friday, July 1**

- Is your sky dark enough for you to see the Coma Berenices star cluster naked-eye? Just after the very end of twilight, spot Jupiter in the west. The cluster is above it by 25°, about 2½ fists at arm's length. Its brightest members form an inverted Y. The entire cluster is about 5° wide — a big, dim glow in a truly dark sky. It nearly fills a binocular view.

Source: Sky & Telescope
ISS Sighting Opportunities

For Denver:

No sightings for Denver through July 3, 2016.

Sighting information for other cities can be found at NASA’s [Satellite Sighting Information](https://nssdc.gsfc.nasa.gov/planetary/sightings/)

NASA-TV Highlights
(all times Eastern Daylight Time)

4 p.m., Tuesday, June 28 - Replay of the 2016 NASA Honor Awards Ceremony (NTV-1 (Public))

8 p.m., Tuesday, June 28 - Replay of the Orbital ATK’s SLS Booster Qualification Motor Test (QM-2) from Promontory, Utah (all channels)

10 p.m., Tuesday, June 28 - Replay of the 2016 NASA Honor Awards Ceremony (NTV-1 (Public))

12:30 p.m., Thursday, June 30 - ISS Expedition 48 In-Flight Educational Event with the Gail Borden Public Library in Elgin, Illinois and ISS Commander Jeff Williams of NASA (starts at 12:35 p.m.) (NTV-1 (Public), NTV-3 (Media))

1 p.m., Thursday, June 30 - NASA Science Briefing on the Juno Orbital Insertion at Jupiter (all channels)

3 p.m., Thursday, June 30 - Video File of the ISS Expedition 48-49 Crew’s Pre-Launch Activities at the Baikonur Cosmodrome in Kazakhstan (Ivanishin, Rubins, Onishi; recorded from June 24-30) (NTV-1 (Public), NTV-3 (Media))

1 a.m., Friday, July 1 - Coverage of the ISS Progress 62 Undocking and Redocking Rendezvous System Test (Undocking scheduled at 1:36 a.m. ET; redocking scheduled at 2:10 a.m. ET) (starts at 1:15 a.m.) (NTV-1 (Public), NTV-3 (Media))

Watch NASA TV online by going to the [NASA website](https://www.nasa.gov/).
Space Calendar

- Jun 28 - Comet 54P/de Vico-Swift-NEAT At Opposition (1.979 AU)
- Jun 28 - Asteroid 19620 Auckland Closest Approach To Earth (2.081 AU)
- Jun 28 - Neptun Trojan 2008 LC18 At Opposition (31.444 AU)
- Jun 28 - 5th Anniversary (2011), Mark Showalter's et al's Discovery of Pluto Moon Kerberos
- Jun 28 - Elon Musk's 45th Birthday (1971)
- Jun 28 - 105th Anniversary (1911), Nakha Meteortite Fall in Egypt (Mars Meteorite, Hit Dog)
- Jun 29 - Asteroid 13667 Samthurman Closest Approach To Earth (1.484 AU)
- Jun 29 - Asteroid 9766 Bradbury Closest Approach To Earth (1.629 AU)
- Jun 29 - Asteroid 4547 Massachusetts Closest Approach To Earth (1.760 AU)
- Jun 29 - Ludmila Pajdusakova's 100th Birthday (1916)
- Jun 30 - Dawn, End of Primary Mission
- Jun 30 - Asteroid Day 2016
- Jun 30 - EKS N2/ Tundra 12L Soyuz-2.1b/Fregat-M Launch
- Jun 30 - Comet 146P/Shoemaker-LINEAR Perihelion (1.430 AU)
- Jun 30 - Asteroid 12608 Aesop Closest Approach To Earth (1.355 AU)
- Jun 30 - Apollo Asteroid 4257 Ubasti Closest Approach To Earth (1.758 AU)
- Jun 30 - Kuiper Belt Object 307261 (2002 MS4) At Opposition (45.826 AU)
- Jun 30 - [Jun 26] Online Lecture: Rover (Robotic and Human-class) Operational Considerations on Mars
- Jun 30 - 45th Anniversary (1971), Death of 3 Cosmonauts in Soyuz 11

- Jul 01 - Comet 207P/NEAT Perihelion (0.937 AU)
- Jul 01 - Amor Asteroid 2016 LZ8 Near-Earth Flyby (0.059 AU)
- Jul 01 - Asteroid 12773 Lyman Closest Approach To Earth (1.741 AU)
- Jul 01 - Iosif Shklovsky's 100th Birthday (1916)

Source: JPL Space Calendar

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New Form Of Atomic Nuclei Just Confirmed, And it Suggests Time Travel is Impossible

PEAR-SHAPED

A new form of atomic nuclei has been confirmed by scientists in a recent study published in the journal *Physical Review Letters*. The pear-shaped, asymmetrical nuclei, first observed in 2013 by researchers from CERN in the isotope Radium-224, is also present in the isotope Barium-144.

This is a monumental importance because most fundamental theories in physics are based on symmetry. This recent confirmation shows that it is possible to have a nuclei that has more mass on one side than the other. “This violates the theory of mirror symmetry and relates to the violation shown in the distribution of matter and antimatter in our Universe,” said Marcus Scheck of University of the West of Scotland, one of the authors of the study.

Until recently, there were three shapes of nuclei — spherical, discuss, and rugby ball. There is a specific combination of protons and neutrons in a certain type of atom that dictates the shape formed by the distribution of charges within a nuclei. These three shapes are all symmetric and agree with the theory known as the CP-symmetry, the combination of charge and parity symmetry.

In the end, this could help us understand why our universe is the way that it is. As astrophysicist Brian Koberlein notes, “It’s been proposed that a violation of CP symmetry could have produced more matter than antimatter, but the currently known violations are not sufficient to produce the amount of matter we see. If there are other avenues of CP violation hidden within pear-shaped nuclei, they could explain this mystery after all.”

NO TIME TRAVEL?

This uneven distribution of mass and charge in the nuclei causes the isotope to ‘point’ in a certain direction in spacetime, and the team suggests that this could explain why time seems to only go forward and not backward.

“We’ve found these nuclei literally point towards a direction in space. This relates to a direction in time, proving there’s a well-defined direction in time and we will always travel from past to present,” Marcus Scheck from the University of the West of Scotland told Kenneth MacDonald at BBC News.

That said, it is a rather speculative hypothesis, but it does raise some rather interesting avenues for investigation.

In the end, this recent discovery is another indication that the Universe might not be what we thought, which could propel us to a new era of theoretical physics.

Source: Futurism

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Space Image of the Week

Juno on Jupiter’s Doorstep

NASA's Juno spacecraft obtained this color view on June 21, 2016, at a distance of 6.8 million miles (10.9 million kilometers) from Jupiter. Juno will arrive at Jupiter on July 4.

As Juno makes its initial approach, the giant planet's four largest moons -- Io, Europa, Ganymede and Callisto -- are visible, and the alternating light and dark bands of the planet's clouds are just beginning to come into view.

Juno is approaching over Jupiter's north pole, affording the spacecraft a unique perspective on the Jupiter system. Previous missions that imaged Jupiter on approach saw the system from much lower latitudes, closer to the planet's equator.

The scene was captured by the mission's imaging camera, called JunoCam, which is designed to acquire high resolution views of features in Jupiter's atmosphere from very close to the planet.

NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the Juno mission for the principal investigator, Scott Bolton, of Southwest Research Institute in San Antonio. The Juno mission is part of the New Frontiers Program managed at NASA's Marshall Space Flight Center in Huntsville, Ala. Lockheed Martin Space Systems, Denver, built the spacecraft. JPL is a division of the California Institute of Technology in Pasadena.

Source: NASA