Space News Update

— May 10, 2019 —

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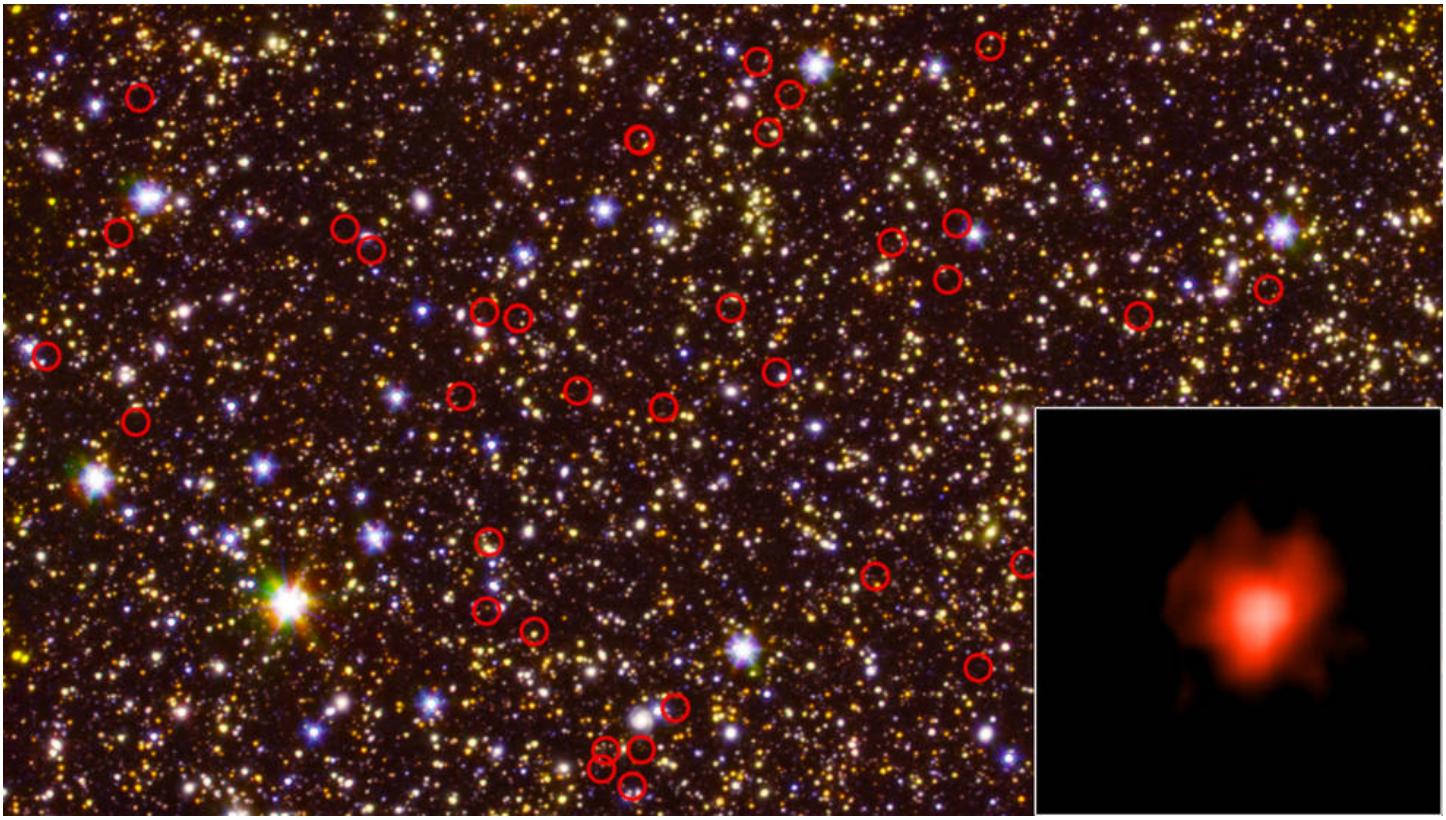
1. **New Clues About How Ancient Galaxies Lit up the Universe**



NASA's Spitzer Space Telescope has revealed that some of the universe's earliest galaxies were brighter than expected. The excess light is a byproduct of the galaxies releasing incredibly high amounts of ionizing radiation. The finding offers clues to the cause of the Epoch of Reionization, a major cosmic event that transformed the universe from being mostly opaque to the brilliant starscape seen today.

In a new study, researchers report on observations of some of the first galaxies to form in the universe, less than 1 billion years after the big bang (or a little more than 13 billion years ago). The data show that in a few specific wavelengths of infrared light, the galaxies are considerably brighter than scientists anticipated. The study is the first to confirm this phenomenon for a large sampling of galaxies from this period, showing that these were not special cases of excessive brightness, but that even average galaxies present at that time were much brighter in these wavelengths than galaxies we see today.

No one knows for sure when the first stars in our universe burst to life. But evidence suggests that between about 100 million and 200 million years after the big bang, the universe was filled mostly with neutral hydrogen gas that had perhaps just begun to coalesce into stars, which then began to form the first galaxies. By about 1 billion years after the big bang, the universe had become a sparkling firmament. Something else had changed, too: Electrons of the omnipresent neutral hydrogen gas had been stripped away in a process known as ionization. The Epoch of Reionization — the changeover from a universe full of neutral hydrogen to one filled with ionized hydrogen — is well documented.

Before this universe-wide transformation, long-wavelength forms of light, such as radio waves and visible light, traversed the universe more or less unencumbered. But shorter wavelengths of light — including ultraviolet light, X-rays and gamma rays — were stopped short by neutral hydrogen atoms. These collisions would strip the neutral hydrogen atoms of their electrons, ionizing them.

But what could have possibly produced enough ionizing radiation to affect all the hydrogen in the universe? Was it individual stars? Giant galaxies? If either were the culprit, those early cosmic colonizers would have been different than most modern stars and galaxies, which typically don't release high amounts of ionizing radiation. Then again, perhaps something else entirely caused the event, such as quasars — galaxies with incredibly bright centers powered by huge amounts of material orbiting supermassive black holes.

"It's one of the biggest open questions in observational cosmology," said Stephane De Barros, lead author of the study and a postdoctoral researcher at the University of Geneva in Switzerland. "We know it happened, but what caused it? These new findings could be a big clue."

Looking for Light

To peer back in time to the era just before the Epoch of Reionization ended, Spitzer stared at two regions of the sky for more than 200 hours each, allowing the space telescope to collect light that had traveled for more than 13 billion years to reach us.

As some of the longest science observations ever carried out by Spitzer, they were part of an observing campaign called GREATS, short for GOODS Re-ionization Era wide-Area Treasury from Spitzer. GOODS (itself an acronym: Great Observatories Origins Deep Survey) is another campaign that performed the first observations of some GREATS targets. The study, published in the Monthly Notices of the Royal Astronomical Society, also used archival data from NASA's Hubble Space Telescope.

Using these ultra-deep observations by Spitzer, the team of astronomers observed 135 distant galaxies and found that they were all particularly bright in two specific wavelengths of infrared light produced by ionizing radiation interacting with hydrogen and oxygen gases within the galaxies. This implies that these galaxies were dominated by young, massive stars composed mostly of hydrogen and helium. They contain very small amounts of "heavy" elements (like nitrogen, carbon and oxygen) compared to stars found in average modern galaxies.

These stars were not the first stars to form in the universe (those would have been composed of hydrogen and helium only) but were still members of a very early generation of stars. The Epoch of Reionization wasn't an instantaneous event, so while the new results are not enough to close the book on this cosmic event, they do provide new details about how the universe evolved at this time and how the transition played out.

"We did not expect that Spitzer, with a mirror no larger than a Hula-Hoop, would be capable of seeing galaxies so close to the dawn of time," said Michael Werner, Spitzer's project scientist at NASA's Jet Propulsion Laboratory in Pasadena, California. "But nature is full of surprises, and the unexpected brightness of these early galaxies, together with Spitzer's superb performance, puts them within range of our small but powerful observatory."

NASA's James Webb Space Telescope, set to launch in 2021, will study the universe in many of the same wavelengths observed by Spitzer. But where Spitzer's primary mirror is only 85 centimeters (33.4 inches) in diameter, Webb's is 6.5 meters (21 feet) — about 7.5 times larger — enabling Webb to study these galaxies in far greater detail. In fact, Webb will try to detect light from the first stars and galaxies in the universe. The new study shows that due to their brightness in those infrared wavelengths, the galaxies observed by Spitzer will be easier for Webb to study than previously thought.

"These results by Spitzer are certainly another step in solving the mystery of cosmic reionization," said Pascal Oesch, an assistant professor at the University of Geneva and a co-author on the study. "We now know that the physical conditions in these early galaxies were very different than in typical galaxies today. It will be the job of the James Webb Space Telescope to work out the detailed reasons why."

JPL manages the Spitzer Space Telescope mission for NASA's Science Mission Directorate in Washington. Science operations are conducted at the Spitzer Science Center at Caltech in Pasadena. Space operations are based at Lockheed Martin Space Systems in Littleton, Colorado. Data are archived at the Infrared Science Archive housed at IPAC at Caltech. Caltech manages JPL for NASA.

For more information on Spitzer, visit www.nasa.gov/spitzer and www.spitzer.caltech.edu/.

Source: NASA Return to Contents

2. Rare-earth Metals in the Atmosphere of a Glowing-hot Exoplanet

KELT-9 b is the hottest exoplanet known to date. In the summer of 2018, a joint team of astronomers from the universities of Bern and Geneva found signatures of gaseous iron and titanium in its atmosphere. Now these researchers have also been able to detect traces of vaporized sodium, magnesium, chromium, and the rare-Earth metals scandium and yttrium.

Exoplanets are planets outside our solar system that orbit around stars other than the Sun. Since the discovery of the first exoplanets in the mid-90's, well over 3000 exoplanets have been discovered. Many of these planets are extreme compared to the planets in our solar system: Hot gas giants that orbit incredibly close to their host stars, sometimes within periods of less than a few days. Such planets do not exist in our solar system, and their existence has defied predictions of how and why planets form. For the past 20 years, astronomers from all over the world have been working to understand where these planets come from, what they are made of, and what their climates are like.

An extremely hot gas giant

KELT-9 is a star located 650 light years from the Earth in the constellation Cygnus. Its exoplanet KELT-9 b exemplifies the most extreme of these so-called hot-Jupiters because it orbits very closely around its star that is almost twice as hot as the Sun. Therefore, its atmosphere reaches temperatures of around 4000 °C. In such heat, all elements are almost completely vaporized and molecules are broken apart into their constituent atoms – much like is the case in the outer layers of stars. This means that the atmosphere contains no clouds or aerosols and the sky is clear, mostly transparent to light from its star.

The atoms that make up the gas of the atmosphere absorb light at very specific colors in the spectrum, and each atom has a unique "fingerprint" of colors that it absorbs. These fingerprints can be measured with a sensitive spectrograph mounted on a large telescope, allowing astronomers to discern the chemical composition of the atmospheres of planets that are many light-years away.

The exoplanet as a treasure trove

A team of researchers from the Universities of Bern and Geneva collaborated to use this technique, and made an interesting discovery: "Using the HARPS-North spectrograph on the Italian National Telescope on the island of La Palma, we found iron and titanium atoms in the hot atmosphere of KELT-9 b," explains Kevin Heng, Director and Professor at the Center for Space and Habitabilty (CSH) at the University of Bern and a member of the National Centre of Competence in Research PlanetS. The team observed the KELT-9 system for a second time last summer, with the goal of confirming their previous detections, but also to proceed to search for additional elements that could be present in the data as well. Their survey included 73 atoms, among which some so-called rare-Earth metals. These substances are less common on Earth, but are applied in advanced materials and devices. Jens Hoeijmakers, who is the first author of the study which is now published in the journal *Astronomy & Astrophysics* and who is a Postdoc at the CSH in Bern and at Geneva Observatory, says: "Our team predicted that the spectrum of this planet could well be a treasure trove where a multitude of species can be detected that have not been observed in the atmosphere of any other planet before."

After careful analysis, the researchers indeed found strong signals of vaporized sodium, magnesium, chromium and the rare-Earth metals scandium and yttrium in the spectrum of the planet. The latter three of these have never been detected robustly in the atmosphere of an exoplanet before. "The team also advanced their interpretation of this data, and were able to use these signals to estimate at what altitude in the planet's atmosphere these atoms are absorbing," says Jens Hoeijmakers. What is more, the researchers also know more about strong global wind patterns high up in the atmosphere that blow the material from one hemisphere to the other.

"With further observations, many more elements may well be discovered by using the same technique in the atmosphere of this planet in the future, and perhaps also on other planets that are heated to similarly high temperatures," explains Jens Hoeijmakers. Kevin Heng adds: "The chances are good that one day we will find so-called biosignatures, i.e. signs of life, on an exoplanet, using the same techniques that we are applying today. Ultimately, we want to use our research to fathom the origin and development of the solar system as well as the origin of life."

Explore further: Iron and titanium in the atmosphere of an exoplanet

Source: Phys.org Return to Contents

3. Commercial Crew Capsules Still Beset by Parachute Problems

A malfunction during a drop test over Nevada last month for SpaceX's Crew Dragon program has engineers re-examining the crew capsule's parachutes, and Boeing has encountered similar parachute failures during testing for its commercial crew capsule, a senior NASA official confirmed Wednesday.

The SpaceX parachute test failure occurred the same month as the explosion of a Crew Dragon spacecraft during a ground test at Cape Canaveral. The parachute drop test over Delamar Dry Lake in Nevada last month did not involve a Crew Dragon capsule, but used a simple metal test sled.

"It failed," said Bill Gerstenmaier, associate administrator of NASA's human exploration and operations directorate. "The parachutes did not work as designed."

The parachutes did not fully open, sources said, and the test sled impacted the ground at a higher-than-expected velocity. Gerstenmaier said the sled was damaged upon impact. The advanced development test was intended to measure loads within each parachute canopy, according to an industry source.

No one was hurt in the test accident.

"It was one single-out test for this parachute," Gerstenmaier said Wednesday in a hearing before the House Committee on Science, Space and Technology's subcommittee on space and aeronautics. "So typically, that test would involve four parachutes, one was proactively failed ahead of time and the three remaining chutes did not operate properly."

Gerstenmaier was asked about the outcome of the SpaceX parachute test by Rep. Mo Brooks, R-Alabama, whose district includes Huntsville and Decatur, home of NASA's Marshall Space Flight Center and the rocket factory for United Launch Alliance, a 50-50 joint venture between Boeing and Lockheed Martin, and a chief rival of SpaceX.

The parachute test failure was not publicized by NASA or SpaceX before Wednesday's congressional hearing.

"The good thing on the test was we had instrumented lines going up to the parachutes, so we know exactly what the loads were in the system," Gerstenmaier said. "But we still need to understand whether it was a test set up configuration coming out of the aircraft or if there was something associated with the packing of the parachutes, the rigging, all of that. This is part of the learning process. By these failures, we're going to learn the data and information to end up with a safe design for our crews. So I don't see this as a negative, this is why we test, this is why we want to push things."

Engineers are investigating whether the parachute malfunction was caused by a problem with the chutes themselves, or as a consequence from the way the test was conducted.

"The test was not satisfactory, we did not get the results we wanted," Gerstenmaier said. "But we learned some information that's going to affect potentially future parachute designs. The other thing we need to understand (are the) test-unique circumstances. Was it driven by an actual design problem in the hardware, or was it driven by the set-up of the test or the particular equipment that was used during the test?"

SpaceX has completed 19 tests of the Crew Dragon's parachute system to date, with a number of additional tests planned before astronauts fly on the spaceship. SpaceX had successfully performed five "parachute-out" tests, in which one of the chutes was deliberately disabled, before last month's test accident, according to an industry source.

NASA officials have long identified parachutes as a concern for SpaceX and Boeing crew capsules, which are in the final stages of development before they carry astronauts into orbit for the first time. After completing their test programs, the SpaceX and Boeing capsules will begin ferrying astronauts to and from the International Space Station, ending NASA's sole reliance on Russian Soyuz spacecraft for crew transportation.

A SpaceX Dragon cargo capsule suffered a parachute anomaly during a return from the International Space Station last year, but recovery crews retrieved the supply ship from the Pacific Ocean as intended.

SpaceX's Dragon cargo ship uses the same main parachutes as the Crew Dragon, also known as Dragon 2. But the heavier Crew Dragon, which is a significantly different spacecraft than the cargo Dragon variant, requires four main parachutes for to slow down for splashdown in the ocean, not the three main chutes used on the currently-flying cargo freighter, sometimes known as Dragon 1.

The Crew Dragon's first test flight in space in early March was successful, and the capsule's parachutes functioned as designed after a six-day unpiloted mission to the space station. The spacecraft that flew to the station in March was destroyed April 20 during an accident at Cape Canaveral, which occurred as the capsule's SuperDraco abort engines were activated for a hold-down firing on a test stand.

Before the April 20 accident, SpaceX aimed to re-fly the Crew Dragon spacecraft on an in-flight abort test in July. Officials hoped to launch a two-man team of NASA astronauts — Bob Behnken and Doug Hurley — on the next Crew Dragon spacecraft to the space station in late September or early October.

SpaceX and NASA officials have not indicated how last month's hotfire test mishap, or the parachute failure, might impact the schedule for the Crew Dragon's first flight with astronauts on-board.

Boeing's CST-100 Starliner crew capsule, which will parachute to ground landings in the Western United States, is set for its first unpiloted test flight to the space station in August, followed by a demonstration mission with three astronauts on-board as soon as November. The Starliner missions will launch on ULA's Atlas 5 rocket, while SpaceX uses its own Falcon 9 launcher for Crew Dragon missions.

Patricia Sanders, chair of NASA's Aerospace Safety Advisory Panel, told members of Congress on Wednesday that parachutes are one of the largest risks faced by SpaceX and Boeing engineers working on NASA's commercial crew program.

"There have been a number of very positive tests, results confirming what we would expect, or desire, in terms of re-entry performance of the parachutes," Sanders said. "There have been a few less satisfactory results, and some tests that are indicating there may need to be some redesign or some adjustments made to the design.

"Those are important to get right before you launch humans," she said.

Lawmakers did not ask Gerstenmaier about Boeing's recent parachute test results. But in response to a question from Spaceflight Now after the hearing, he confirmed that Starliner parachute drop tests have encountered anomalies similar to the one suffered by SpaceX last month.

"We've gotten data that is unique, that will help us understand if this is something that needs to be fixed or if it's something that's just a nuance of the test and the configuration," Gerstenmaier said of last month's SpaceX parachute test failure.

Source: Spaceflight Now Return to Contents

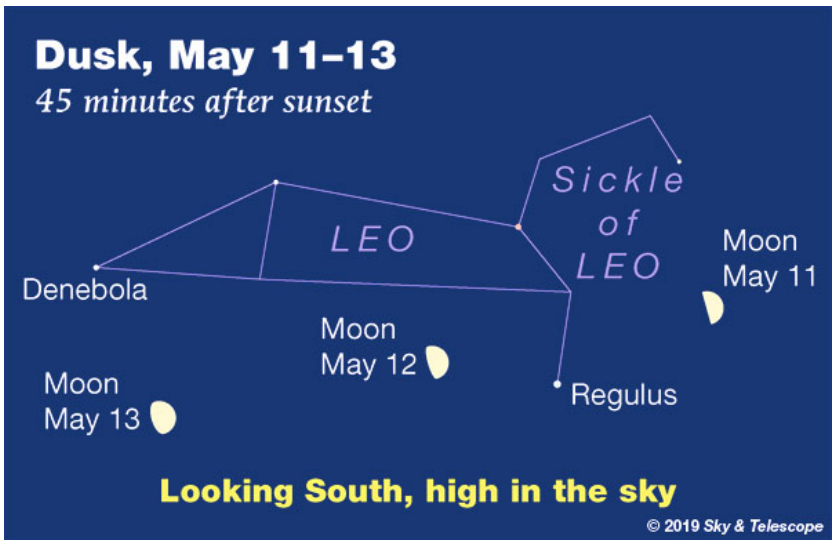
The Night Sky

Friday, May 10

• The Moon, nearly first quarter, crosses the Beehive star cluster (M44) this evening for much of North America. Many faint occultations will be visible telescopically on the Moon's dark limb, writes David Dunham: "Occultations of 6th to 9th-magnitude stars in rapid succession will occur as the 39% sunlit Moon passes over M44, visible in part from most of North America east of the Rocky Mountains, with northeastern areas favored. A Moonview and information about computing local predictions is on the IOTA occultation campaigns page." (The Universal Time date is May 11th.) See our article The Moon Bumbles Into the Beehive.

Saturday, May 11

• First-quarter Moon (exact at 9:12 p.m. Eastern Daylight Time). The Moon shines some 10° to the right of Regulus. Above Regulus is Algieba (Gamma Leonis), only a little fainter. They're the two brightest stars of the Sickle of Leo.



Sunday, May 12

• As night descends, look west for Pollux and Castor lined up almost horizontally (depending on your latitude). These heads of the Gemini twins form the top of the enormous Arch of Spring. To their lower left is Procyon, the left end of the Arch. Farther to their lower right is the other end, formed by Menkalinan (Beta Aurigae) and then brilliant Capella.

Monday, May 13

• Look above the Moon this evening for Denebola (Beta Leonis), the tail tip of Leo.

You'll find bright Arcturus way off to Denebola's left, by three or four fists at arm's length.

Tuesday, May 14

• Vega is now well up in the east-northeast after dark. Look for its faint little constellation Lyra, the Lyre, hanging down from it.

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver: No Sighting Opportunities

Date	Visible	Max Height	Appears	Disappears
Sat May 11, 3:49 AM	1 min	10°	10° above NNW	10° above N
Sat May 11, 5:26 AM	< 1 min	11°	10° above NNW	11° above NNW
Sun May 12, 2:58 AM	2 min	11°	10° above NNW	11° above N
Sun May 12, 4:35 AM	2 min	13°	10° above NNW	13° above NNE
Mon May 13, 2:08 AM	< 1 min	12°	12° above N	12° above N
Mon May 13, 3:45 AM	< 1 min	11°	10° above N	11° above N
Mon May 13, 5:20 AM	3 min	26°	10° above NNW	26° above NNE

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

NASA-TV Highlights

(all times Eastern Daylight Time)

No Special Programming

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

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Space Calendar

- May 10 - Asteroid 7169 Linda Closest Approach To Earth (1.304 AU)
- May 10 - Asteroid 6594 Tasman Closest Approach To Earth (1.746 AU)
- May 10 - Asteroid 64070 NEAT Closest Approach To Earth (1.997 AU)
- May 10 - Asteroid 3264 Bounty Closest Approach To Earth (2.067 AU)
- May 10 - Asteroid 31000 Rockchic Closest Approach To Earth (2.088 AU)
- May 10 - 140th Anniversary (1879), Estherville Meteorite Shower in Iowa
- May 11 - Comet C/2018 W1 (Catalina) Perihelion (1.360 AU)
- May 11 - Comet C/2019 D1 (Flewelling) Perihelion (1.578 AU)
- May 11 - Comet P/2005 T2 (Christensen) At Opposition (2.165 AU)
- May 11 - Comet C/2017 T3 (ATLAS) At Opposition (3.244 AU)
- May 11 - NEW [May 09] Apollo Asteroid 2019 JV2 Near-Earth Flyby (0.046 AU)
- May 11 - Apollo Asteroid 468005 (2012 XD112) Near-Earth Flyby (0.098 AU)
- May 11 - Asteroid 2867 Steins Closest Approach To Earth (1.262 AU)
- May 11 - Asteroid 1000 Piazzia Closest Approach To Earth (1.470 AU)
- May 11 - Asteroid 12818 Tomhanks Closest Approach To Earth (1.689 AU)
- May 11 - Asteroid 3255 Tholen Closest Approach To Earth (2.312 AU)
- May 11 - 10th Anniversary (2009), STS-125 Launch (Space Shuttle Atlantis, Last Hubble Space Telescope Servicing)
- May 11 - Antony Hewish's 95th Birthday (1924)
- May 12 - Comet 250P/Larson At Opposition (2.640 AU)
- May 12 - Comet 138P/Shoemaker-Levy At Opposition (2.706 AU)
- May 12 - NEW [May 09] Apollo Asteroid 2019 JO2 Near-Earth Flyby (0.009 AU)
- May 12 - NEW [May 04] Apollo Asteroid 2019 JL Near-Earth Flyby (0.036 AU)
- May 12 - Aten Asteroid 2009 FU23 Near-Earth Flyby (0.071 AU)
- May 12 - Aten Asteroid 2100 Ra-Shalom Closest Approach To Earth (0.474 AU)
- May 12 - Asteroid 71000 Hughdowns Closest Approach To Earth (2.167 AU)
- May 12 - Kuiper Belt Object 90568 (2004 GV9) At Opposition (38.611 AU)
- May 13 - Comet 74P/Smirnova-Chernykh Closest Approach To Earth (2.863 AU)
- May 13 - Comet P/2007 R2 (Gibbs) At Opposition (2.970 AU)
- May 13 - Comet 162P/Siding Spring At Opposition (3.261 AU)
- May 13 - Comet 224P/LINEAR-NEAT At Opposition (3.817 AU)
- May 13 - Comet 316P/LONEOS-Christensen At Opposition (3.913 AU)
- May 13 - Comet P/2015 Q1 (Scotti) At Opposition (4.063 AU)
- May 13 - Asteroid 5720 Halweaver Closest Approach To Earth (1.367 AU)
- May 13 - Lecture: Exploring Planets Orbiting Nearby Stars, Kamuela, Hawaii
- May 13 - NEW [Mar 04] Seminar: Simpson's Paradox in Galactic Archaeology, Barcelona, Spain

Source: JPL Space Calendar

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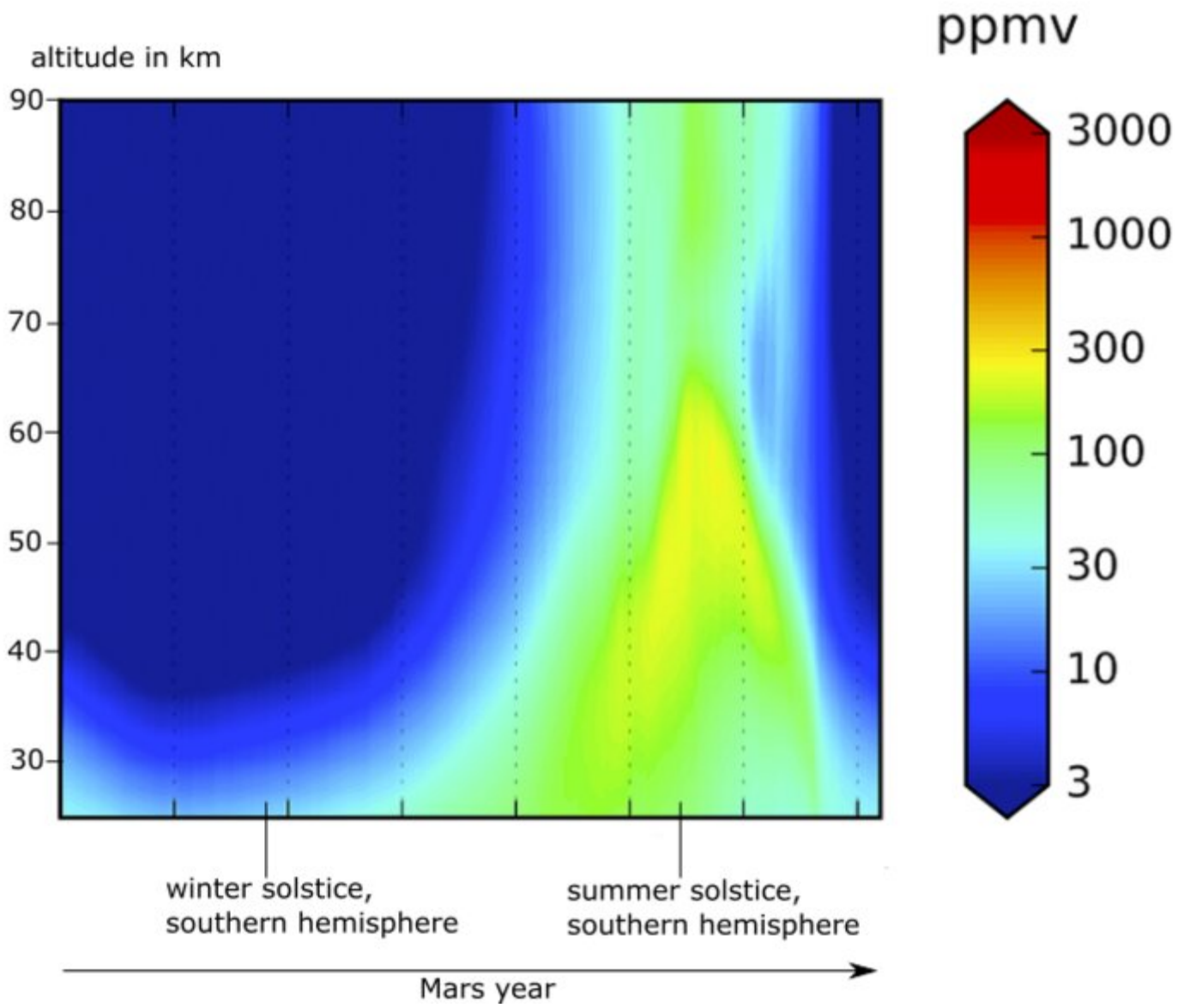
Food for Thought

New Water Cycle on Mars Discovered



Approximately every two Earth years, when it is summer on the southern hemisphere of Mars, a window opens: Only in this season can water vapor efficiently rise from the lower into the upper Martian atmosphere. There, winds carry the rare gas to the north pole. While part of the water vapor decays and escapes into space, the rest sinks back down near the poles. Researchers from the Moscow Institute of Physics and Technology and the Max Planck Institute for Solar System Research (MPS) in Germany describe this unusual Martian water cycle in a current issue of the *Geophysical Research Letters*. Their computer simulations show how water vapor overcomes the barrier of cold air in the middle atmosphere of Mars and reaches higher atmospheric layers. This could explain why Mars, unlike Earth, has lost most of its water.

Billions of years ago, Mars was a planet rich in water with rivers, and even an ocean. Since then, our neighboring planet has changed dramatically. Today, only small amounts of frozen water exist in the ground; in the atmosphere, water vapor occurs only in traces. All in all, the planet may have lost at least 80 percent of its original water. In the upper atmosphere of Mars, ultraviolet radiation from the sun split water molecules

into hydrogen (H) and hydroxyl radicals (OH). The hydrogen escaped from there irretrievably into space. Measurements by space probes and space telescopes show that even today, water is still lost in this way. But how is this possible? The middle atmosphere layer of Mars, like Earth's tropopause, should actually stop the rising gas. After all, this region is usually so cold that water vapor would turn to ice. How does the Martian water vapor reach the upper air layers?

In their current simulations, the Russian and German researchers find a previously unknown mechanism reminiscent of a kind of pump. Their model comprehensively describes the flows in the entire gas envelope surrounding Mars from the surface to an altitude of 160 kilometers. The calculations show that the normally ice-cold middle atmosphere becomes permeable to water vapor twice a day—but only at a certain location, and at a certain time of year.

The orbit of Mars plays a decisive role in this. Its path around the sun, which lasts about two Earth years, is much more elliptical than that of our planet. At the point closest to the sun (which roughly coincides with the summer of the southern hemisphere), Mars is approximately 42 million kilometers closer to the sun than at its furthest point. Summer in the southern hemisphere is therefore noticeably warmer than summer in the northern hemisphere.

"When it is summer in the southern hemisphere, at certain times of day, water vapor can rise locally with warmer air masses and reach the upper atmosphere," says Paul Hartogh from MPS, summarizing the results of the new study. In the upper atmospheric layers, air flows carry the gas along the longitudes to the north pole, where it cools and sinks down again. However, part of the water vapor escapes this cycle: under the influence of solar radiation, the water molecules disintegrate and hydrogen escapes into space.

Another Martian peculiarity can fortify this unusual hydrological cycle: huge dust storms that span the entire planet and repeatedly afflict Mars at intervals of several years. The last such storms occurred in 2018 and 2007 and were comprehensively documented by space probes orbiting Mars. "The amounts of dust swirling through the atmosphere during such a storm facilitate the transport of water vapor into high air layers," says Alexander Medvedev from MPS.

The researchers calculated that during the dust storm of 2007, twice as much water vapor reached the upper atmosphere as during a stormless summer in the southern hemisphere. Since the dust particles absorb sunlight and thus heat up, the temperatures in the entire atmosphere rise by up to 30 degrees. "Our model shows with unprecedented accuracy how dust in the atmosphere affects the microphysical processes involved in the transformation of ice into water vapor," explains Dmitry Shaposhnikov of the Moscow Institute of Physics and Technology, first author of the new study.

"Apparently, the Martian atmosphere is more permeable to water vapor than that of the Earth," Hartogh concludes. "The new seasonal water cycle that has been found contributes massively to Mars' continuing loss of water."

Explore further: Dust storms linked to gas escape from Martian atmosphere

Source: Phys.org Return to Contents

Space Image of the Week

Liftoff of SpaceX's CRS-17 Dragon Cargo Craft

Explanation SpaceX's Dragon lifted off on a Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station in Florida on Saturday, May 4, with more than 5,500 pounds of research, equipment, cargo and supplies that will support dozens of investigations aboard the International Space Station. On Monday, May 6, while the station was traveling over the north Atlantic Ocean, astronauts David Saint-Jacques of the Canadian Space Agency and Nick Hague of NASA grappled Dragon at 7:01 a.m. EDT using the space station's robotic arm, Canadarm2.

Image Credit: SpaceX

Source: NASA Image of the Day

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