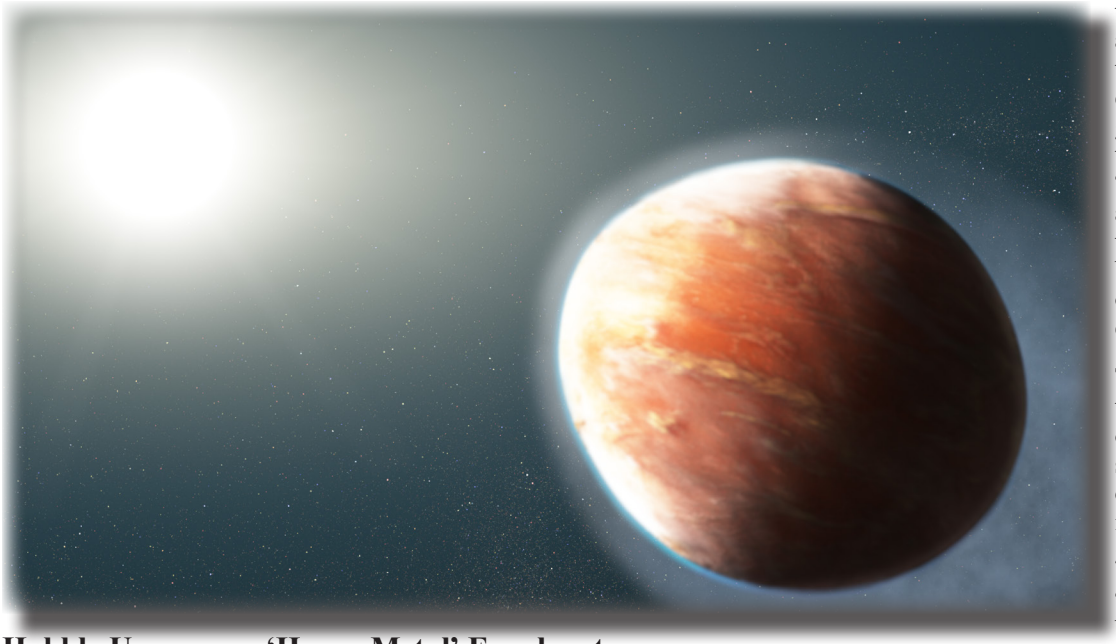
Shasta Astronomy Club Newsletter



Hubble Uncovers a 'Heavy Metal' Exoplanet Shaped Like a Football

How can a planet be "hotter than hot?" The answer is when heavy metals are detected escaping from the planet's atmosphere, instead of condensing into clouds.

Observations by NASA's Hubble Space Telescope reveal magnesium and iron gas streaming from the strange world outside our solar system known as WASP-121b. The observations represent the first time that so-called "heavy metals"—elements heavier than hydrogen and helium—have been spotted escaping from a hot Jupiter, a large, gaseous exoplanet very close to its star.

Normally, hot Jupiter-sized planets are still cool enough inside to condense heavier elements such as magnesium and iron into clouds.

But that's not the case with WASP-121b, which is orbiting so dangerously close to its star that its upper atmosphere reaches a blazing 4,600 degrees Fahrenheit. The temperature in WASP-121b's upper atmosphere is about 10 times greater than that of any known planetary atmosphere. The WASP-121 system resides about 900 light-years from Earth.

"Heavy metals have been seen in other hot Jupiters before, but only in the lower atmosphere," explained lead researcher David Sing of the Johns Hopkins University in Baltimore, Maryland. "So you don't know if they are escaping or not. With WASP-121b, we see magnesium and iron gas so far away from the planet that they're not gravitationally bound."

Ultraviolet light from the host star, which is brighter and hotter than the Sun, heats the upper atmosphere and helps lead to its escape. In addition, the escaping magnesium and iron gas may contribute to the temperature spike, Sing said. "These metals will make the atmosphere more opaque in the ultraviolet, which could be contributing to the heating of the upper atmosphere," he explained.

The sizzling planet is so close to its star that it is on the cusp of being ripped apart by the star's gravity. This hugging distance means that the planet is football shaped due to gravitational tidal forces.

"We picked this planet because it is so extreme," Sing said. "We thought we had a chance of seeing heavier elements escaping. It's so hot and so favorable to observe, it's the best shot at finding the presence of heavy metals. We were mainly looking for magnesium, but there have been hints of iron in the atmospheres of other exoplanets. It was a surprise, though, to see it so clearly in the data and at such great altitudes so far away from the planet. The heavy metals are escaping partly because the planet is so big and puffy that its gravity is relatively weak. This is a planet being actively stripped of its atmosphere."

Shasta Astronomy Club Newsletter

This Impact Crater Was Likely Ground Zero for an Ancient Mega-Tsunami on Mars

By Mike Wall

Lomonosov Crater may be ground zero.

Ground zero for the impact that caused a Mars mega-tsunami more than 3 billion years ago may have been found.

The meteor that spawned that ancient flood probably blasted out Lomonosov Crater, a 75-mile-wide (120 kilometers) hole in the ground in the icy plains of the Martian Arctic, a new study reports.

Lomonosov's large size suggests that the impactor itself was big — similar in scale to the 6-mile-wide (10 km) asteroid that hit Mexico's Yucatan Peninsula 66 million years ago, sparking a mass extinction that killed off 75% of Earth's species, including the dinosaurs.

Such big space rocks don't hit the Red Planet (or Earth) very often. So, the new study provides some important clues about Mars' ancient northern ocean, and the planet's past potential to host life as we know it, team members said.

"The implication is that the ocean would have retained a liquid component for a very long time," study co-author Alexis Rodriguez, a senior scientist at the Planetary Science Institute in Tucson, Arizona, told Space.com. He offered 4 million to 5 million years as a representative figure, but stressed that the number is just an estimate.

A cold and mysterious ocean

Mars' big, salty northern ocean likely formed about 3.4 billion years ago. The ocean's existence is widely accepted by Mars researchers, Rodriguez said, but there is considerable debate about its nature.

For example, some scientists believe the ocean was relatively long-lived, if quite cold. But others don't think the ancient Martian climate could have supported stable bodies of surface water for long, and therefore argue that the ocean froze over very quickly — perhaps in a few thousand years or less.

The new study, which was published in late June in the Journal of Geophysical Research: Planets, bolsters the former viewpoint.

Rodriguez and his colleagues, led by François Costard of the French National Center for Scientific Research, built upon several years of previous research into the ocean and its imprints on the landscape of ancient Mars.

For example, Rodriguez led a 2016 study that identified huge lobes in the northern plains — features that strongly resemble marks left by tsunamis here on Earth. The team determined that

the lobes were carved out by two different mega-tsunamis, which flooded the region more than 3 billion years ago.

Mars does not have significant plate-tectonic activity, so the big waves were probably unleashed by impacts. So, Costard, Rodriguez and their colleagues hunted for craters left behind by the cosmic culprits, narrowing the search over the next few years.

That search may now be over, at least for one of the two impactors. Multiple lines of evidence point to Lomonosov, the scientists report in the new study. For example, Lomonosov is in the right place, it's the right age (as determined by crater counts), and it looks a lot like marine craters here on Earth.

Lomonosov fits the bill in other ways as well. For instance, the crater is about as deep as scientists think the shallow northern ocean was at the time of impact. And part of Lomonosov's rim is missing, which is consistent with a mega-tsunami; the displaced water may have knocked this big chunk free as it raged.

While this evidence is suggestive, however, it does not yet rise to the level of a smoking gun, Rodriguez said.

"This crater is a candidate," he said. "I would not go so far as to say this is definitely the crater that produced the tsunami."

That tsunami, by the way, is probably the first of the two big floods that Rodriguez and his colleagues identified back in 2016. That earlier mega-tsunami featured both runoff and backwash flows, the latter of which are caused by water returning to the sea. Lomonosov seems to have been carved by both types of flows.

The second mega-tsunami caused runoff but not backwash, suggesting that Mars, and the ocean, may have been colder at the time. It's possible the northern ocean had a significant amount of ice cover when this other impactor came crashing down, he added.

Boosting the case for Mars life?

Lomonosov is interesting enough on solely geological grounds.

"This is possibly the first time that a potential marine crater associated with a tsunami has been investigated outside Earth," Rodriguez said.

And then there are the astrobiological implications. As noted above, Lomonosov's size suggests the northern ocean — a potentially habitable environment — persisted for a relatively long time. It's statistically unlikely, after all, that the Lomonosov impact occurred right after this liquid ocean formed.

And even if the ocean were largely frozen at the time, the impact would have created an environment favorable to life as we know it: The tremendous energy unleashed would have melted lots of ice and created a hydrothermal system at Lomonosov, Rodriguez said.

The crater is therefore a tantalizing target for future life-hunting missions. Robotic explorers probably aren't up to the task, however, because the Lomonosov area is covered by an ice layer about 33 feet (10 meters) thick, Rodriguez said.

But human explorers could probably drill down through the ice and access sediments on the crater floor. And these pioneers could use the abundant water ice for life support, providing an exploration twofer.

"That would be very interesting," Rodriguez said.

Shasta Astronomy Club Newsletter

HUBBLE UNCOVERS BLACK HOLE DISK THAT SHOULDN'T EXIST

HUBBLE OFFERS PEEK AT MATERIAL SWIRLING CLOSE TO A BLACK HOLE

Astronomers are always tickled when they find something they didn't expect to be there. Peering deep into the heart of the majestic spiral galaxy NGC 3147, researchers uncovered a swirling gas disk precariously close to a black hole weighing about 250 million times the mass of our Sun. The surprise is that they thought the black hole was so malnourished, it shouldn't have such a structure around it. It's basically a "Mini-Me" version of more powerful disks seen in very active galaxies.

What's especially intriguing is that the disk is so deeply embedded in the black hole's intense gravitational field, its light is being stretched and intensified by the black hole's powerful grasp. It's a unique, real-world demonstration of Einstein's laws of relativity, formulated a century ago.

Hubble clocked material whirling around the black hole as moving at more than 10% of the speed of light. And, the gas astronomers measured is so entrenched in the gravitational well that light is struggling to climb out, and therefore appears stretched to redder wavelengths.

As if black holes weren't mysterious enough, astronomers using NASA's Hubble Space Telescope have found an unexpected thin disk of material furiously whirling around a supermassive black hole at the heart of the magnificent spiral galaxy NGC 3147, located 130 million light-years away.

The conundrum is that the disk shouldn't be there, based on current astronomical theories. However, the unexpected presence of a disk so close to a black hole offers a unique opportunity to test Albert Einstein's theories of relativity. General relativity describes gravity as the curvature of space and special relativity describes the relationship between time and space.

"We've never seen the effects of both general and special relativity in visible light with this much clarity," said Marco Chiaberge of the European Space Agency, and the Space Telescope Science Institute and Johns Hopkins University, both in Baltimore, Maryland, a member of the team that conducted the Hubble study.

"This is an intriguing peek at a disk very close to a black hole, so close that the velocities and the intensity of the gravitational pull are affecting how the photons of light look," added the study's first author, Stefano Bianchi of Università degli Studi Roma Tre, in Rome, Italy. "We cannot understand the data unless we include the theories of relativity."

Black holes in certain types of galaxies like NGC 3147 are malnourished because there is not enough gravitationally captured material to feed them regularly. So, the thin haze of infalling material puffs up like a donut rather than flattening out

in a pancake-shaped disk. Therefore, it is very puzzling why there is a thin disk encircling a starving black hole in NGC 3147 that mimics much more powerful disks found in extremely active galaxies with engorged, monster black holes.

"We thought this was the best candidate to confirm that below certain luminosities, the accretion disk doesn't exist anymore," explained Ari Laor of the Technion-Israel Institute of Technology located in Haifa, Israel. "What we saw was something completely unexpected. We found gas in motion producing features we can explain only as being produced by material rotating in a thin disk very close to the black hole."

The astronomers initially selected this galaxy to validate accepted models about lower-luminosity active galaxies—those with black holes that are on a meager diet of material. Models predict that an accretion disk forms when ample amounts of gas are trapped by a black hole's strong gravitational pull. This infalling matter emits lots of light, producing a brilliant beacon called a quasar, in the case of the most well-fed black holes. Once less material is pulled into the disk, it begins to break down, becomes fainter, and changes structure.

"The type of disk we see is a scaled-down quasar that we did not expect to exist," Bianchi said. "It's the same type of disk we see in objects that are 1,000 or even 100,000 times more luminous. The predictions of current models for gas dynamics in very faint active galaxies clearly failed."

The disk is so deeply embedded in the black hole's intense gravitational field that the light from the gas disk is modified, according to Einstein's theories of relativity, giving astronomers a unique look at the dynamic processes close to a black hole.

Hubble clocked material whirling around the black hole as moving at more than 10% of the speed of light. At those extreme velocities, the gas appears to brighten as it travels toward Earth on one side, and dims as it speeds away from our planet on the other side (an effect called relativistic beaming). Hubble's observations also show that the gas is so entrenched in the gravitational well the light is struggling to climb out, and therefore appears stretched to redder wavelengths. The black hole's mass is around 250 million Suns.

The researchers used Hubble's Space Telescope Imaging Spectrograph (STIS) to observe matter swirling deep inside the disk. A spectrograph is a diagnostic tool that divides light from an object into its many individual wavelengths to determine its speed, temperature, and other characteristics at a very high precision. The astronomers needed STIS's sharp resolution to isolate the faint light from the black-hole region and block out contaminating starlight.

"Without Hubble, we wouldn't have been able to see this because the black-hole region has a low luminosity," Chiaberge said. "The luminosities of the stars in the galaxy outshine anything in the nucleus. So if you observe it from the ground, you're dominated by the brightness of the stars, which drowns the feeble emission from the nucleus."

The team hopes to use Hubble to hunt for other very compact disks around low-wattage black holes in similar active galaxies.

The team's paper will appear online today in the Monthly Notices of the Royal Astronomical Society.

The international team of astronomers in this study consists of Stefano Bianchi (Università degli Studi Roma Tre, Rome, Italy); Robert Antonucci (University of California, Santa Barbara, California); Alessandro Capetti (INAF - Osservatorio Astrofisico di Torino, Pino Torinese, Italy); Marco Chiaberge (Space Telescope Science Institute and Johns Hopkins University, Baltimore, Maryland); Ari Laor (Israel Institute of Technology, Haifa, Israel); Loredana Bassani (INAF/IASF Bologna, Italy); Francisco Carrera (CSIC-Universidad de Cantabria, Santander, Spain); Fabio La Franca, Andrea Marinucci, Giorgio Matt, and Riccardo Middei (Università degli Studi Roma Tre, Roma, Italy); and Francesca Panessa (INAF Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy).

The Hubble Space Telescope is a project of international cooperation between NASA and ESA (European Space Agency). NASA's Goddard Space Flight Center in Greenbelt, Maryland, manages the telescope. The Space Telescope Science Institute (STScI) in Baltimore, Maryland, conducts Hubble science operations. STScI is operated for NASA by the Association of Universities for Research in Astronomy in Washington, D.C.

Shasta Astronomy Club Newsletter

August 2019						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	6	7	8	9 Friday Night Astronomy 9:00pm Oak Bottom Marina	10 Perseid Meteor Shower 9:00pm Oak Bottom Marina
11	12	13	14	15	16 Friday Night Astronomy 9:00pm Oak Bottom Marina	17
18	19	20	21	22	23 Friday Night Astronomy 9:00pm Oak Bottom Marina	24 Girl Scout Viewing Event Bumpass Hell Lassen Volcanic National Parkk
25	26	27	28	29	30 Friday Night Astronomy 9:00pm Oak Bottom Marina	31 Club Breakfast 8:00am Humble Joes Star Party 9:00pm Oak Bottom Marina

Star Party Location: Oak Bottom Marina Parking Lot