[An online publication of the Milwaukee Lunar Reclamation Society, a chapter of the Moon Society and of the National Space Society as well as an "Outpost" of the Mars Society]

>> All past issues of Outbound are online at:
http://www.moonsociety.org/publications/outbound/

OUTBOUND #31, DECEMBER, 2020

Mars is a seismically active world, results from InSight lander reveal

www.space.com/nasa-insight-lander-mars-seismically-active.html

The first official science results from NASA's quake-hunting InSight Mars lander just came out, and they reveal a regularly roiled world.

"We've finally, for the first time, established that Mars is a seismically active planet," InSight principal investigator Bruce Banerdt, of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, said during a teleconference with reporters Thursday (Feb. 20).

"Martian seismicity falls between that of the Moon and that of Earth." In fact, it's probably close to the kind of seismic activity you would expect to find away from the [tectonic] plate boundaries on Earth and away from highly deformed areas,"

Insight touched down near the Martian equator in November 2018, kicking off a two-year, $850 million mission to probe the Red Planet's interior in unprecedented detail.

The stationary lander carries two main science instruments to do this work: a supersensitive suite of seismometers and a burrowing heat probe dubbed "the mole," which is designed to get at least 10 feet (3 meters) below the Red Planet's surface.

√ **Analyses of marsquake and heat-transport measurements will allow the mission team to construct a detailed, 3D map of the Martian interior**. In addition, InSight scientists are √ **using radio signals beamed from the lander to track how much Mars wobbles on its axis over time**. This information will help researchers √ **determine how big and dense the planet's core is.**

(The **Insight** mission's full name — **I**nterior **E**xploration using **S**eismic **I**nvestigations, **G**eodesy and **H**eat **T**ransport — references these various lines of investigation.)

Overall, InSight's observations will help scientists ***better understand how rocky planets such as Mars, Earth, Mercury, and Venus form and evolve.***##

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Dead Cassini spacecraft could solve mystery of Saturn's hot atmosphere

By Elizabeth Howell 5/7/2020

"The results are vital to general understanding of planetary upper atmospheres."

A spacecraft that died in 2017 is still providing insights about Saturn, the planet it studied up close for 13 years.

NASA's **Cassini** spacecraft helped scientists to discover why Saturn's upper atmosphere is so hot, which puzzled planetary scientists for decades since the planet is too far from the sun to receive our star's heat. But, using old data from Cassini, scientists are closer to solving this mystery.

This new work, which was conducted by **NASA and the European Space Agency** and led by Zarah Brown, a graduate student at ***the University of Arizona's Lunar and Planetary Laboratory***, suggests that ***it's auroras that are heating up Saturn's atmosphere.*** These auroras are ***triggered by the constant stream of charged particles from the solar wind, which interacts with charged particles that flow from Saturn's moons and creates electric currents.***

This insight not only helps scientists understand what is going on at Saturn, but perhaps also at gas giant planets in general. Jupiter, Neptune and Uranus all have strangely hot upper atmospheres as well.

There are also numerous exoplanet gas giants far outside of our solar system that may exhibit similar behavior.

[skip]

In this study, this map helped scientists to study ***how electric currents from Saturn's auroras heats the planet's upper atmosphere, generating the solar wind.***

The solar wind, in turn, distributes energy from the poles (where the auroras are located) towards the equator. That energy then heats the equator to twice the temperatures than could be generated from the sun's heat.

This particular dataset came from Cassini's final few months at Saturn when it did 22 very close orbits of the gas giant before deliberately hurling itself into the planet on Septeme 15, 2017 (to prevent possible Earthly contamination of Saturn's icy moons, which could host microbial life.)

For six weeks, Cassini examined bright stars in the constellations Orion and Canis Major, watching as the stars rose and set behind Saturn. By observing the shifting starlight, scientists were able to learn more about the density of Saturn's atmosphere. Since density decreases with altitude, the rate of decrease is dependent on temperature, allowing scientists to estimate temperatures in Saturn's upper atmosphere.

Cassini's observations showed the temperatures peaking around the auroras, in turn providing ***evidence that it is electric currents are what Saturn's upper atmosphere so hot***. Wind speeds on Saturn were also determined using density and temperature measurements. ##

EDITOR: **Does this study and fresh insight on Saturn throw some light on the origin and long life of Jupiter's Great Red Spot? and/or on the outer two gas giants, Uranus and Neptune?** PK

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A paper based on the research was published Monday (April 6) in Nature Astronomy. \

- Cassini's Death Dive into Saturn Reveals Weird Ring 'Rain' & Other Surprises https://www.space.com/42022-cassini-saturn-finale-ring-rain-surprises.html

April 16, 19, 2020: **Saturn's Moon Titan May Have 'Phantom Lakes' and Caves**. Picture a world where rain falls, gathers in **lakes** and ponds, seeps into the surrounding rock, and evaporates away, only to fall again. ... Papers explore how this eerily familiar, waterless "water cycle" manifests on **Titan's** surface.

https://www.accuweather.com/en/weather-news/**saturns-moon-titan-may-have-phantom-lakes-and-caves**/3165

Picture a world where rain falls, gathers in lakes and ponds, seeps into the surrounding rock, and evaporates away, only to fall again. There's just one catch: The world is Saturn's moon, **Titan, where the rain is liquid methane.**

Two new papers explore how this eerily familiar, waterless "water cycle" manifests on Titan's surface. Two separate research teams turned to data from the Cassini mission, which ended its stay at the Saturn system in September 2017. The spacecraft flew past the massive moon more than 100 times, gathering crucial observations of this strange world as it did so.

Some of those observations showed scientists something truly extraordinary: their first glimpse of liquid currently on the landscape, rather than mere ghosts of such liquid

features. "**Titan is the only world outside the Earth where we see bodies of liquid on the surface,**" said Rosaly Lopes, a planetary scientist at NASA's Jet Propulsion Laboratory who worked on the Cassini mission but wasn't involved in either of the new papers. "Some of us like to call Titan the Earth of the outer solar system."

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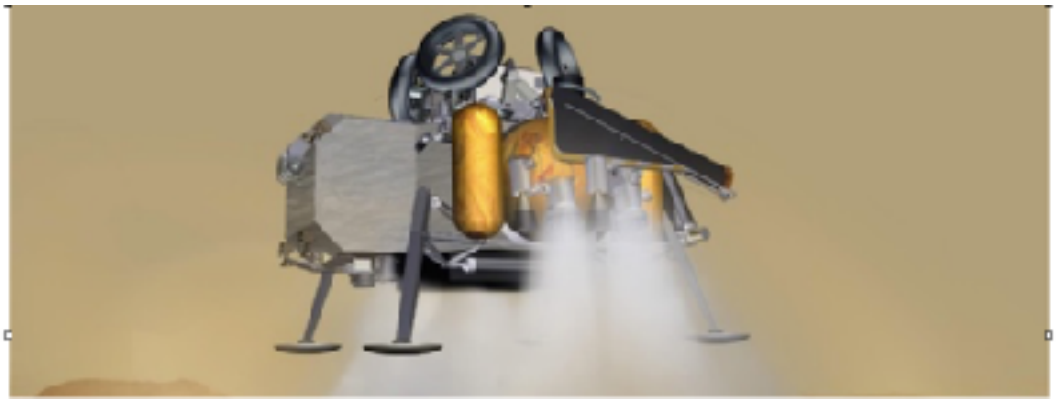
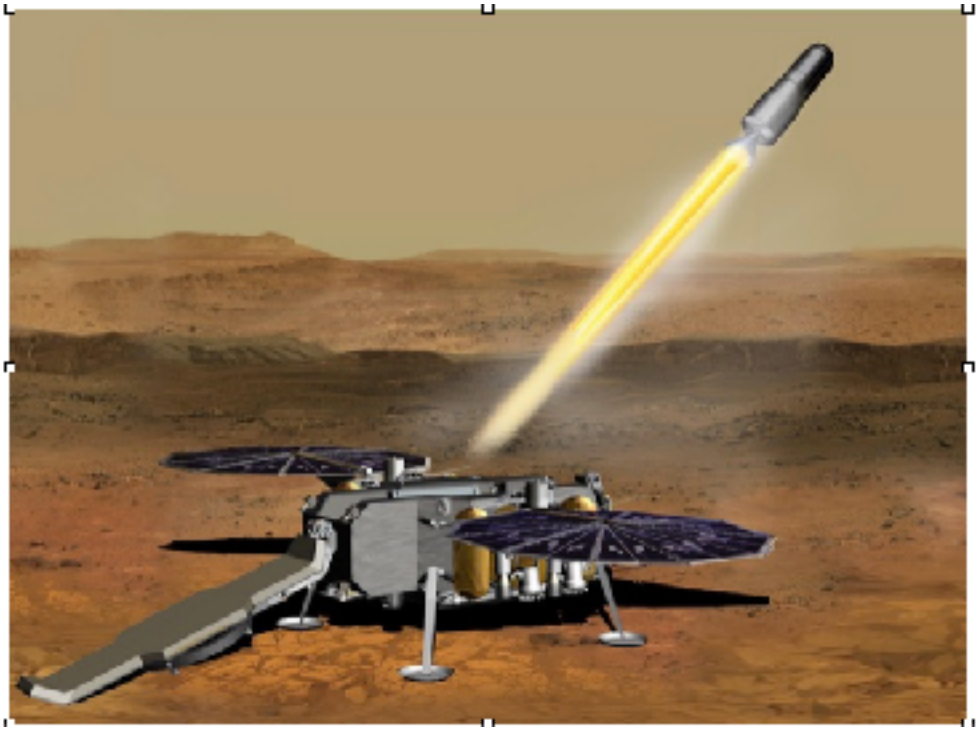
Taking on the Challenge of Mars Sample Return

by Jeff Foust: https://www.thespacereview.com/article/3930/1

Illustrations from a recent NASA presentation of a Mars Ascent Vehicle, carrying samples from the surface, launching those samples into orbit.





Returning samples of Mars soil will be an enormous step forward.
Who knows what all surprises we will find in these samples? ##

Colonizing Mars may require humanity to tweak its DNA

By Mike Wall May 19, 2020

https://www.space.com/mars-colony-human-genetic-engineering-tardigrades.html

If humanity is ever going to settle down on Mars, we may need to become a little less human.

Crewed missions to Mars, which NASA wants to start flying in the 2030s, will be tough on astronauts, ***exposing them to high radiation loads, bone-wasting microgravity and other hazards for several years at a time.*** But these pioneers should still be able to make it back to Earth in relatively good nick, agency officials have said.

Genetic engineering and **other advanced technologies** "may need to come into play if people want to live and work and thrive, and establish their family, and stay on Mars," Kennda Lynch, an astrobiologist and geomicrobiologist at the Lunar and Planetary Institute in Houston, said on May 12 during a webinar hosted by the New York Academy of Sciences called #Alienating Mars: Challenge of Space Colonization."

https://www.nyas.org/events/2020/webinar-alienating-mars-challenges-of-space-colonization/

"That's when these kinds of technologies might be critical or necessary."

Coming soon?

Genetic enhancement may not be restricted to the pages of sci-fi novels for much longer. For example, scientists have already inserted genes from tardigrades — tiny, adorable and famously tough animals that can survive the vacuum of space — into human cells in the laboratory. The engineered cells exhibited a greater resistance to radiation than their normal counterparts, said fellow webinar participant Christopher Mason, a geneticist at Weill Cornell Medicine, the medical school of Cornell University in New York City.

NASA and other space agencies already take measures to protect their astronauts physically, via spacecraft shielding, and pharmacologically via a variety of medicines. So, it's not a huge conceptual leap to consider protecting them genetically as well, provided that these measures are proven to be safe, Mason said.

"And are we maybe ethically bound to do so?" he said during the webinar. "I think if it's a long enough mission, you might have to do something, assuming it's safe, which we can't say yet."

Tardigrades and **"extremophile" microbes**, such as the radiation-resistant bacterium Deinococcus radiodurans, "are a great, basically natural reservoir of amazing traits and talents in biology." Mason has been studying the effects of long-term spaceflight on NASA astronaut Scott Kelly who spent nearly a year aboard the International Space Station in 2015-16

Harnessing these traits might also someday allow astronauts to journey farther than Mars, out to some even more exotic and dangerous cosmic locales. For instance, a crewed journey to Jupiter's moon, **Europa**, which harbors a huge ocean beneath its icy shell, is out of the question at the moment. In which harbors a huge ocean beneath its icy shell, is out of the question at the moment. In addition to being very cold, Europa lies in the heart of Jupiter's powerful radiation belts.

"If we ever get there, those are the cases where the human body would be almost completely fried by the amount of radiation There, it would be certain death unless you did something, including every kind of shielding you could possibly provide."

Genetic engineering at least lets us consider the possibility of sending astronauts to Europa, which is widely regarded as one of the solar system's best bets to harbor alien life. (The Jovian satellite is a high priority for NASA's robotic program of planetary exploration. In the mid-2020s, the agency will launch a mission called "**Europa Clipper**", which will assess the moon's habitability during dozens of flybys. **Congress has ordered NASA to develop a robotic Europa lander as well**, though this remains a concept mission at the moment.)

Not just us

Genetic engineering almost certainly won't be restricted to pioneering astronauts and colonists. Recent advances in synthetic biology herald a future in which "designer microbes" help colonists establish a foothold on the Red Planet, Lynch said.

"These are some of the things that we can actually do to help us make things we need, help us make materials to build our habitats," she said. "And these are a lot of things that scientists are researching right now — to create these kinds of things for our trip to Mars."

Some researchers and exploration advocates have even suggested using designer microbes to terraform Mars, turning it into a world much more comfortable for humans. This possibility obviously raises big ethical questions, especially considering that Mars may have hosted life in the ancient past and might still host it today, in subsurface lakes or aquifers. (Permanently changing our own

genomes for radiation protection or any other reason may also strike some folks as ethically dubious, of course.)

Most astrobiologists argue against terraforming Mars, ***stressing that we don't want to snuff out or fundamentally alter a native ecosystem that may have arisen on the Red Planet. That would be both unethical and unscientific***, Lynch said.

After all, she said, one of the main reasons we're exploring Mars is to determine if Earth is the only world to host life.

"And how can we do that if we go and change the planet before we go and find out if life actually was living there?" Lynch said.

Mike Wall is the author of "Out There"(Grand Central Publishing, 2018; a book about the search for alien life. ##

Editors Comment (Peter Kokh): Unlike the Moon which has no atmosphere, so that settlers can create an Earth-like atmosphere within the walls of lunar settlements, Mars has an atmosphere, albeit a very thin one, and an unbreathable one. So ***Martians themselves*** must do like wise, an earth like breathable one within their habitats and the passageways connecting them.

As to vegetation, if we can breed various plants (food, clothing, etc) in an earth like atmosphere within the corridors and pressurized walkways and streets) then plants brought from Earth, especially those who can thrive in thinner Earth-like atmosphere, should do.

If we want plants for whatever purpose, i.e. fiber, clothing, food, etc. an Earthlike atmosphere, even if thinner as around mountainous plateaus on Earth, should do. **But if we can breed plants that will survive "outdoors" on Mars, that's a whole new matter.** We might start with plants that grow at the highest altitudes on Earth and breed them to adjust on Mars, whose atmosphere is quite different (not just thinner, *way thinner*.) PK

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Announcing the 2020 Lunar Development Conference, a virtual event on July 19 & July 20, 2020
Organized by The Moon Society
with assistance from other space advocacy groups.

The Moon Society, a non-profit advocacy organization dedicated to returning humans to exploration of the Earth's Moon and creating sustainable commercial settlements, announces the 2020 Lunar Development Conference: a new online virtual event to be held on Sunday, July 19th and Monday, July 20th.

Registration is now open for the general public. Tickets to the event are $10, which can be applied to a membership in the Moon Society. Current members as well as full-time students and seniors (60+) are able to register for free.

The Lunar Development Conference will bring together astronauts, lunar scientists, business leaders, moon base designers, and space enthusiasts to discuss all aspects of lunar exploration and settlement.

Speakers at the virtual conference are planned to include:

- Michael Mealling – President, The Moon Society & General Partner, Starbridge Venture Capital
- Sean Mahoney – CEO, Masten Space Systems to discuss their involvement with NASA's CLPS program.
- Dr. Doug Plata – President & Founder, Space Development Network
- Ben Smith – Founder, Lunar Homestead
- James L. Burk – Vice President, The Moon Society & Senior Manager, Artic Consulting
- Other CLPS program participants
- Other prominent Lunar scientists and researchers

The latter day coincides with the 51st anniversary of the Apollo 11 Moon landing.

All presentations will be given online and attendees will be able to fully participate in Q&A, networking activities, and adhoc meeting spaces using a new virtual software platform and mobile application.

The hashtag #LunarDevCon will be the official social media hashtag for the event, and will be used extensively during our promotion and during the event.

Those interested in presenting at the Lunar Development Conference can submit an abstract using the form at www.MoonSociety.org/LDC

Sponsorships for the event are available to qualifying companies and organizations. Sponsors are provided co-promotions during and after the event and additional access to connect with attendees. Please inquire to vice-president@moonsociety.org

xsWe thank the community for its support as we seek to ignite commercial lunar development and promote the vision of human lunar exploration and settlement. We'll see you in July!

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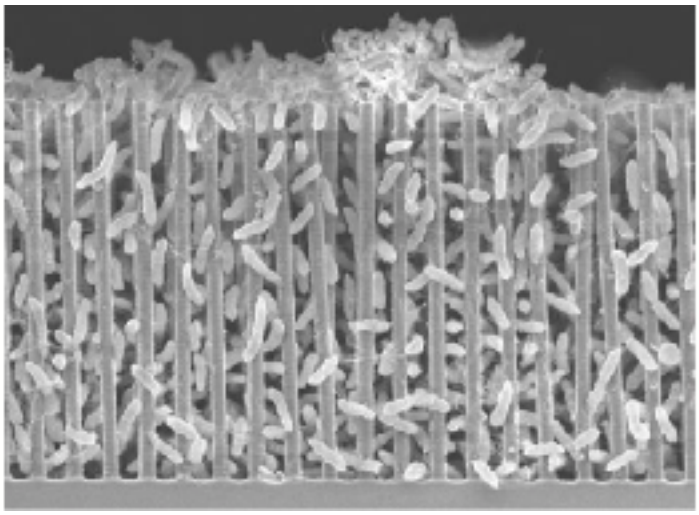
"The" instead of "the"

I'll give up and agree to write/type the moon (instead of The Moon)

***if* you agree to write/type the united states (instead of The United States)**

and the hawaiian islands instead of the Hawaiian Islands, and the hague instead of The Hague, and the netherlands instead of the Netherlands, the united kingdom instead of The United Kingdom, and the earth instead of the Earth.



When We Settle on Mars, How We'll Build Lifefrom the Ground Up

A biohybrid scaffold of bacteria and nanowires could reduce carbon dioxide and help us live on Mars.

•Payload logistics are key to any space travel, and self-replicating organisms are immensely valuable.

•These bacteria convert carbon dioxide and water into life-building acetate molecules.

Scientists from the University of California, Berkeley have built a nano-sized power plant, emphasis on "plant": their device uses sunlight to convert carbon dioxide and water into new organic molecules.

The device is an assemblage of bacteria attached to a scaffold of nanowires. Researchers say it could be key to enabling the manufacture of a variety of vital ingredients for drugs and more for future Mars settlers.

Very little of Earth's atmosphere is carbon dioxide—and here, it takes very little difference to disrupt life and the ecosystem. But the atmosphere of Mars is almost inverted, with 96 percent carbon dioxide instead of the about 1 percent on Earth. Capitalizing on the most plentiful atmospheric gas is just good math in terms of building a plausible way to live on Mars.

On Earth, plants live on sunlight, but do it inefficiently. The most efficient plant on Earth, the researchers say, is sugar cane, which can convert up to 5 percent of sunlight and carbon dioxide into sugar. The structure of the nano power plant is a two-part system that mimics how mechanisms function for real plants. A frame made of nanowires draws in electrons that serve as food for the vital bacteria attached to the frame, and these bacteria convert the electrons into acetate molecules.

Acetate is the common term for a kind of consumer plastic, but that's only the tiniest tip of the acetate iceberg. In its simplest chemical form, acetate, or acetic acid, is vinegar. Acetate molecules are key to building many of the components of life through biosynthesis. Molecules in the body, like amino acids and cholesterols, are biosynthesized.

"Acetate molecules can serve as building blocks for a range of organic molecules, from fuels and plastics to drugs," the Cal scientists said in a statement. "Many other organic products could be made from acetate inside genetically engineered organisms, such as bacteria or yeast."

Chemistry professor and project lead Peidong Yang says the group is working on similar systems that could produce "sugar and carbohydrates"—again a souped-up biohybrid based on how plants operate.

The idea of living on Mars is still pretty far out in terms of feasibility, but the Cal team hopes this bacterial nanoscaffold could have applications for reducing pollution on Earth. On Mars, carbon dioxide is the only logical choice for a naturally abundant fuel source. On Earth, grabbing carbon dioxide from the air and turning it into energy could end up making a difference in environmental outcomes. That's still a faraw bf v ay goal, too, but one that's a little more down to Earth.

And in the long term, this NASA-sponsored research could indeed make a big difference. "For a deep space mission, you care about the payload weight," Yang said. "[B]iological systems have the advantage that they self-reproduce: You don't need to send a lot. That's why our biohybrid version is highly attractive." ##

WHY WE WILL CONTINUE TO "SEE" OPTICAL ILLUSIONS OF LIFE

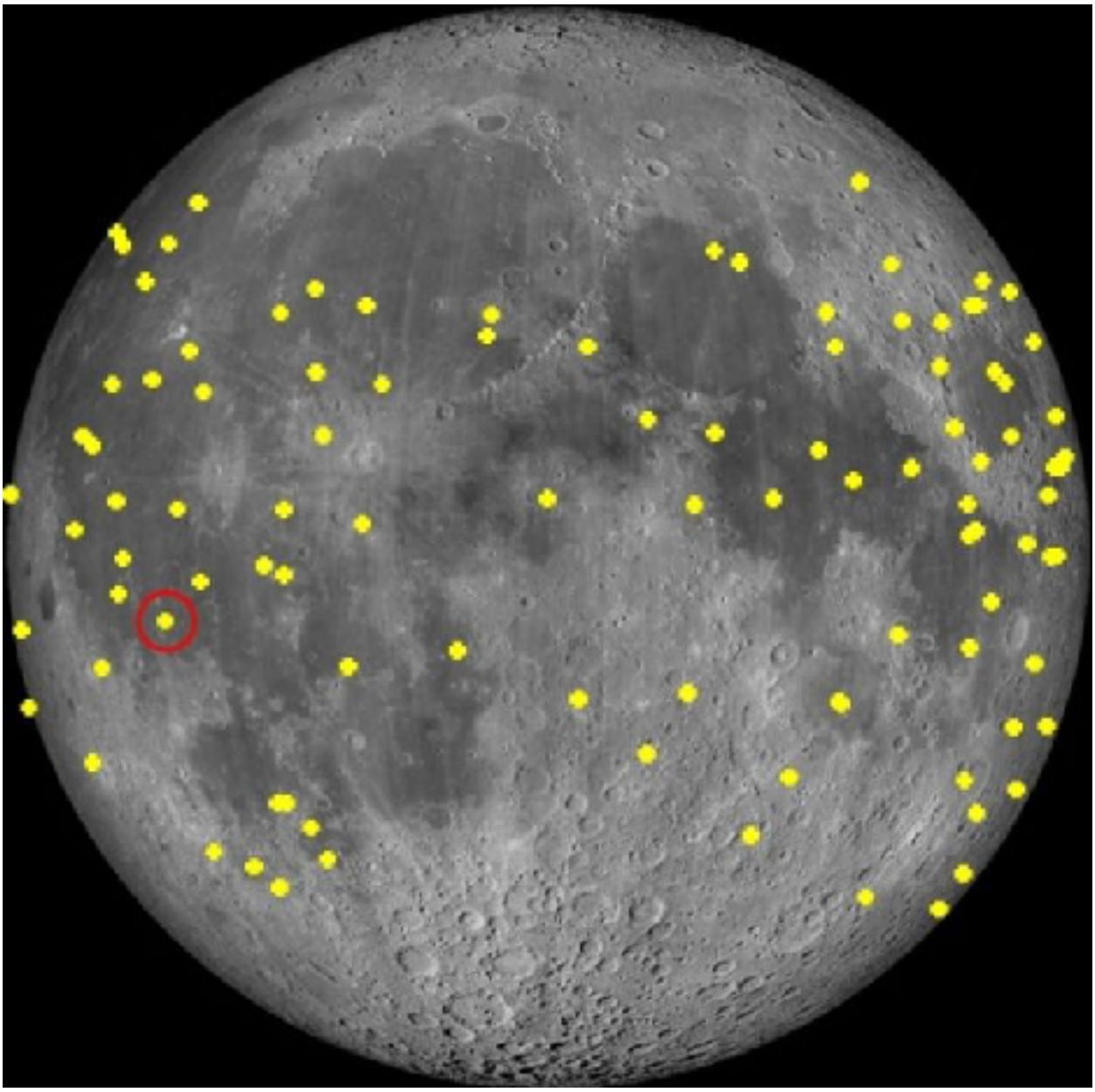
https://www.google.com/search?channel=mac_bm&sxsrf=ALeKk000JOKTc1NXZvuxY-HI-5EL0VRyvw:1586893874769&q=boulders+that+look+like+animals&tbm=isch&source=univ&client=safari&sa=X&ved=2ahUKEwjVlc6t2OjoAhWKbc0KHc87CTQQsAR6BAgFEAE&biw=1324&bih=770&safari_group=9

[The above link shows **hundreds of boulders and rocks that from one angle or more look like animals. We have all been born on a world full of animals, birds in the sky, all kinds of animals on the ground, some underwater. and for buildings too!**

And the unconscious search on Mars (and on the Moon) for **boulders whose shapes (at least seen from one angle that look like animals.** We share our world with all sorts of animals including birds. **Finding boulders that give a touch of a world that pioneers on the Moon and Mars have left behind will be natural. .##**

The hunt for asteroid impacts on the Moon heats up with new observatory

www.space.com/asteroid-impacts-on-moon-new-observatory.html



A map showing detections of flashes caused by asteroids impacting the Moon. The circled impact is the 100th detected by NELIOTA and the first observed by the Sharjah Lunar Impact Observatory, on March 1, 2020.
(Image credit: ESA/NELIOTA)

Sometimes a flash in the night is actually an **asteroid** slamming into the Moon.

Because such impacts offer valuable information about Earth's own barrage of space rocks, scientists have established programs that look for the brief bright flashes on the Moon that represent lunar impacts. A new such telescope recently began operations, confirming observations of another telescope's 100th impact flash detection.

Having multiple eyes on the moon is valuable for scientists because other phenomena, like satellites passing overhead, can produce similar flashes in the data. But two observatories at different locations won't simultaneously see the same satellite: if both catch the same lunar flash at the same time, it's definitely real data.

The European Space Agency's **N**ear-**E**arth **O**bject **L**unar **I**mpacts and **O**ptical **T**ransients (NELIOTA) project, based at Kryoneri Observatory in Greece, does just this type of work. So far, the project has spent nearly 150 hours staring at the moon and observed 102 flashes The instrument can also provide data that lets scientists estimate the temperature of the impact.

The milestone 100th observation came on March 1. And as scientists looked back over NELIOTA's data, they realized that a newcomer to the lunar impact patrol, the Sharjah Lunar Impact Observatory in the United Arab Emirates, had spotted the same flash. Scientists were able to compare images taken by the two observatories and line up lunar features, in addition to checking the timestamps of the flashes.

The double observation marks an important milestone for lunar impact surveillance efforts. "Cross detections like this are very useful as they rule out the possibility of a slow, bright satellite being misidentified as an impact flash. ##

EDITOR: Of course, over the aeons, **vastly larger impacts** have carved out the much larger features of the Moon's "face", the side facing Earth, as well as the hidden "far side" permanently "from Earth." ##

Revisiting the Tunguska Meteor or Comet Impact over Northern Siberia in Eastern Russia in 2008

https://www.space.com/tunguska-meteor-impact-explained.html?

A Meteor that blasted millions of trees in Siberia only 'grazed' Earth, new research says

*13*By Mindy Weisberger May 29, 2020

This destructive cosmic event has puzzled scientists for more than a century

A mysterious blast in 1908, thought to have been caused by a meteor, flattened a Siberian taiga forest. This photo was taken in 1938, during an expedition by Russian mineralogist Leonid Kulik, investigating the event.

(Image: © Sovfoto/Universal Images Group via Getty Images)

A new explanation for a massive blast over a remote Siberian forest in 1908 is even stranger than the mysterious incident itself.

Known as the Tunguska event, the blast flattened more than 80 million trees in seconds, over an area spanning nearly 800 square miles (2,000 square kilometers) — but left no crater. A meteor that exploded before hitting the ground was thought by many to be the culprit. However, a comet or asteroid would likely have left behind rocky fragments after blowing up, and no "smoking gun" remnants of a cosmic visitor have ever been found.

On the morning of June 30, 1908, the sky above Siberia flared so bright and hot that a witness standing dozens of kilometers from the site thought that his shirt had caught fire, said Vladimir Pariev, co-author of the new Tunguska study and a researcher with the P. N. Lebedev Physical Institute of the Russian Academy of Sciences in Moscow.

Following the bright light, which lasted for about 1 minute, was an explosion that smashed windows and knocked people off their feet in a town more than 35 miles (60 km) away, the BBC reported. "The sky was split in two, and high above the forest the whole northern part of the sky appeared covered with fire," another witness said in a testimonial. Energy released by the blast was later estimated by scientists to be 185 times greater than that of the atomic bomb dropped on Hiroshima in 1945, according to NASA.

Initial explanations for the blast included volcanic eruptions and mining accidents, according to NASA, but those claims were not supported by physical evidence. Other later suggestions were more far-fetched, such as a crashed UFO or a black hole collision with Earth — a study describing the black hole hypothesis was published in the journal Nature in 1973 (and was soundly debunked in another Nature study published just a few months later).

The most widely accepted scientific explanation is that a rocky asteroid or comet entered Earth's atmosphere and then disintegrated with a bang about 3 to 6 miles (5 to 10 km) above the ground, Pariev told Live Science in an email. **But such an explosion should have strewn the ground with rocky debris, which no one has ever found.** By comparison, a meteor that exploded over Chelyabinsk, Russia, in February 2013 broke into fragments that were discovered within a week, Pariev said.

What if, the researchers questioned, the Tunguska meteor were made of iron rather than rock? Could a massive iron meteor "graze" Earth's atmosphere, approaching close enough to generate a powerful shock wave,

then yank free of the planet's gravitational pull and escape without fragmenting?

To test that hypothesis, the scientists calculated meteor paths using computer models. They looked at objects that were as small as 164 feet (50 meters) across and as large as 656 feet (200 m) in diameter. Objects were made of rock, ice or iron, and approached in a trajectory that brought them within 6 to 10 miles (10 to 15 km) of Earth's surface.

The scientists' calculations showed that space bodies made of rock and ice would completely disintegrate under the enormous pressures generated by their passage through the tropospheric altitudes. "***Only asteroids made of iron larger than 100 m [328 feet] in diameter can survive and not get cracked and fragmented into many separate pieces,***" they said.

The researchers estimated that the Tunguska meteor likely measured between 328 and 656 feet (100 and 200 m) in diameter, and hurtled through Earth's atmosphere at roughly 45,000 mph (72,000 km/h). During its fiery passage, the meteor would lose some of its mass. ***But iron shed by a meteor traveling at such speeds would have escaped as gas and plasma, oxidized in the atmosphere and then dispersed on the ground, becoming nearly indistinguishable from terrestrial iron oxides, according to the study.***

Prior studies have calculated the power of shock waves produced by meteors based on the object entering Earth's atmosphere at a very steep angle "and either hitting the ground or exploding in midair," Pariev said.

In the case of the Tunguska meteor, the iron-rich space object could have entered Earth's atmosphere at a very shallow angle — about 9 to 12 degrees tangential to the surface. It then would have grazed through the atmosphere, creating a shock wave at an altitude of around 6 to 10 miles (10 to 15 km) above the ground, capable of flattening trees for hundreds of kilometers and scorching the surface. ***But because of the meteor's mass and momentum, it didn't break up; it then exited the atmosphere and returned to space, the researchers reported.***

However, some lingering questions about this scenario remain, said Mark Boslough, a research professor at the University of New Mexico and physicist with Los Alamos National Laboratory.

Boslough, who was not involved in the study, told Live Science in an email that if an object "skimmed through the atmosphere" and didn't blow up, the resulting shock wave would be significantly weaker than an explosion's blast wave.

"***An object that survived such a transit through the atmosphere could not have descended close enough to the surface for a sonic boom to do the kind of damage that was observed at Tunguska,***" Boslough said.

What's more, the pattern of felled trees at the site is radial — emanating from a single point of tremendous energy release, he said. That's something you'd expect to see after an explosion rather than a sonic boom, "even if it had been strong enough to blow trees over." Boslough added that eyewitness accounts at the time of the incident "are consistent with an object that was descending toward the surface before it exploded."

While the study authors didn't numerically calculate the impact of a shock wave that a "grazing" iron meteor of this size could produce, their estimates still suggest that such a wave would be powerful enough to flatten trees and damage the ground as the Tunguska event did, Pariev said in the email. [Flattening 2,000 km^2 (770 sq mi) of forest] "Detailed calculations of the shock waves from a grazing asteroid is the subject of our ongoing research," he added.

The findings were published online in the March issue of the journal Monthly Notices of the Royal Astronomical Society.

[EDITOR] In August **1981**, I was on a tour through Russia (Moscow, Leningrad (St. Petersbuerg) Sochi (a most beautiful city on the Black Sea) then down to Tblissi, Georgia (the personal highlight of my tour), down to Erevan (at the North foot of Mt. Arararat where Noah's ark supposedly landed) back to Moscow, then East to Bratsk, Siberia to see a total eclipse of the Sun.

Minutes to go, the sky was still cloudy and our Intourist guide said that if we did not get to see the total eclipse of the Sun (behind the Moon) that they would take us in a plane 600 km NNE to the Tunguska site. With a minute to spare, the clouds parted and we saw our eclipse. We did not know whether to laugh or cry.

Years later, My brother and I drove up to the summit of Mt. St. Helens 50 miles NE of Portland, Oregon and 96 miles south of Seattle, Washington that had blown its top in a violent eruption twenty years earlier. There we saw all the leafless trees on the ground facing away from the crater, but with beautiful plants and flowers sticking up between the dead trees. ***Awesome beyond belief!*** And so if I did not get to see Tunguska in Siberia, I got to see something similar.

I had learned enough Russian to bolt the group and go off on my own.

And if someone approached me and said something in Russian, I would answer **"po angliski?"** And more often than not the answer was, "**Of course!**" in English.

Yes, I even got inside the Kremlin and I looked straight up and quietly said "Hello, U.S Missile #1!" But I fell in love with Moscow so let's hope no missiles will fly in either direction. Others liked Leningrad (St. Petersburgh) more, but not me.##

New SpaceX spacesuits get five-star rating from NASA astronauts

https://www.space.com/spacex-spacesuits-five-star-astronaut-review.html

The movie-star look to SpaceX's new spacesuits is just one of the innovative features the Crew Dragon astronauts enjoyed during the Demo-2 test flight to the International Space Station.

NASA astronauts Doug Hurley and Bob Behnken were the first humans to wear the suits in space during their mission, which began May 30 with a flawless launch from Florida — the first human spaceflight from the region since the space shuttle program ended in 2011.

Things have changed since then. Instead of the old-school "pumpkin suit" launch suits Behnken and Hurley wore multiple times for space shuttle missions, this time the veteran astronauts were decked in all-white SpaceX suits for their rocket ride to orbit.

"I bet you we've donned and offed those suits a couple hundred times," Hurley said from on board the space station. The SpaceX spacesuits were custom-made for the astronauts and thus used extensively during training for the Demo-2 mission.

Because the spacesuits were fitted to the astronauts' individual body types, Hurley added, "they were actually much easier to get in and out of in zero G," or weightlessness, compared to the pumpkin suits, which were also called the Advanced Crew Escape Suit (ACES). ACES and the SpaceX spacesuits are not designed for spacewalks — just for backup during launches and landings. ***Comfier in Space!***

"We'd have to get the suits a five-star rating," Behnken added during the discussion about the SpaceX suits. He pointed to some of the primary functions of the spacesuit, which is to protect the astronauts in case of fire or depressurization aboard SpaceX's Crew Dragon spacecraft.

Astronauts Doug Hurley (left) and Bob Behnken in their SpaceX spacesuits at Launch Pad 39A with their Falcon 9 rocket and Crew Dragon spacecraft in the background before launch. The SpaceX pressure suits are designed to keep astronauts safe in the spacecraft and not for spacewalks. (Image credit: Kim Shiflett/NASA)

Both astronauts thanked the ground crews for their work in developing the spacesuits, which was done to very closely tune the spacesuits to the functionality of Crew Dragon. The gloves were designed to work with the spacecraft touchscreens, and the spacesuits were made to plug into seat umbilicals carrying oxygen and cool air from the spacecraft.

"One of the things that was important in the development of the suit was to make it easy to use, something that the crew just literally has to plug in when they sit down, and the suit takes care of things from there," said Chris Trigg, SpaceX's spacesuits and crew equipment manager, in a May 27 video SpaceX posted to

The spacesuit has been tested in space before, just to make sure it was ready for humans. A version flew on the Tesla-driving dummy SpaceX launched towards Mars orbit in 2018, and another spacesuit decked thee dummy Ripley that flew aboard the uncrewed SpaceX Crew Dragon Demo-1 test flight to the space station in 2019. ##

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Mystery solved:
Odd bright patches on Saturn moon Titan are dry lake beds

https://www.space.com/saturn-moon-titan-bright-spots-mystery-solved.html

The features had puzzled scientists for more than a decade. A perplexing Saturn moon mystery appears to be solved at long last.

Strange bright patches observed in the southern tropical regions of Saturn's biggest moon, Titan, more than a decade ago are likely the beds of dried-up hydrocarbon lakes and seas, a new study reports.

The results could shed light on Titan's climate history and also inform the hunt for potentially habitable environments on alien planets.

Between the years 2000 and 2008, the big radio telescopes at Arecibo Observatory in Puerto Rico and the Green Bank Observatory in West Virginia spotted about a dozen anomalously bright regions on the 3,200-mile-wide (5,150 kilometers) Titan, the second-largest moon in the solar system (in between Jupiter’s Ganymede and Callisto).

At the time, the patches were viewed as likely evidence of lakes or seas on Titan, which was widely expected to harbor such bodies, said study lead author Jason Hofgartner, of NASA's Jet Propulsion Laboratory in Pasadena, California.

That early expectation was borne out after NASA's Cassini spacecraft arrived in orbit around Saturn in 2004. Cassini observed many lakes and seas on Titan and showed that the moon has an active weather system based on liquid hydrocarbons. Methane and ethane fall from the sky as rain, course down river systems and pool in lakes and seas, some of which are bigger than North America's Great Lakes.

Titan remains the only cosmic body beyond Earth known to harbor bodies of stable liquid on its surface.

But the lakes spotted by Cassini sit primarily near Titan's poles, especially the moon's far northern reaches. The probe didn't see bodies of liquid where the patches detected by the Arecibo and Green Bank dishes lie, in the southern tropics.

So Hofgartner and his colleagues decided to delve into the mystery. They pored over all the available data sets, using Cassini's observations to "ground-truth" the information gathered by Arecibo and Green Bank.

The researchers tied the reflective patches identified by the radio telescopes to a single "terrain unit," which has smoother surfaces and a different composition than the surrounding landscape. Such features are characteristic of dry lake or sea beds.

Here on Earth, for example, evaporated seas leave behind relatively flat surfaces that are saltier than their surroundings. Vanished Titan seas would not have been salty, but they may well have contained dissolved organic molecules that could make a similar mark on the landscape.

"The preponderance of evidence all seems to be consistent with that" explanation, Hofgartner told Space.com. The evidence includes dry lake beds Cassini observed in the polar regions, which look a lot like what the radio dishes saw closer to the equator.

The team cannot rule out the possibility that the mysterious bright regions are actually shallow pools of recently fallen hydrocarbon rain. But that seems quite unlikely, given how infrequently cloudbursts occur on Titan, Hofgartner said. During its 13-plus years in the Saturn system, Cassini observed just two rainfall events — one in 2004 and another one in 2010.

The new study opens a window on Titan's climate evolution, showing that conditions on the big moon have changed over time. But the nature and extent of that change aren't clear at the moment. For example, have liquid hydrocarbons just shifted position on Titan's surface, moving from the tropics to the poles? Or are the dry lake beds evidence that Titanic methane and ethane are being depleted, and will eventually disappear completely? Solar radiation, after all, is known to destroy methane in the big moon's atmosphere.

"My personal suspicion is, there's going to be a little bit of both at play here," Hofgartner said. The new results could also be useful to astrobiologists, planetary

scientists and anyone else interested in characterizing potentially habitable environments on alien worlds, he added. The Cassini, Arecibo and Green Bank data show that anomalous bright patches by themselves are not sufficient evidence to establish the presence of a current-day lake or sea, be it filled with water or methane; such features could just show where such a body used to be.

Indeed, active lakes and seas on Titan have a different signature — a brightness that's much more coherent, as a result of these bodies' incredible smoothness. (Winds on Titan are virtually nonexistent, so the moon's lakes and seas are almost mirror-flat.)

And there's another message as well, he stressed. Though the Cassini spacecraft is dead — its handlers steered the low-on-fuel probe intentionally into Saturn's atmosphere in September 2017 — giving to the scientific community for many years to come.

"I think this just speaks to how wonderful a mission Cassini was," Hofgartner said. "There's still lots of work to be done analyzing Cassini data, and I think there are amazing discoveries just waiting to be found in that data set."

- Landing on Titan: Pictures from Huygens probe on Saturn moon
- https://www.space.com/16130-titan-landing-saturn-moon-huygens-pictures.html
- The rings and moons of Saturn (photos)
- https://www.space.com/10850-planet-saturn-moons-rings-cassini-spacecraft.html
- In photos: Cassini mission ends with epic dive into Saturn

One of Titan's "Great Lakes" comparison with one of Earth's Great Lakes

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