CORNELL ASTRONOMICAL SOCIETY NEWSLETTER

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LETTER FROM THE PRESIDENT

Happy fall to all! We've been in full swing here at the Cornell Astronomical Society this semester—having club dinner at Apple Fest, running two monthly telescope trainings alongside our weekly open house nights, and kicking off a lecture series! We heard from two club members about their summer research and learned about purple aliens with Dr. Ligia Coelho.

Behind the scenes, us officers have been working tirelessly on the budget (Haonan Gong, Treasurer), lectures (Ben Shapiro, Outreach), museum (Ben Jacobson-Bell, VP), newsletters (Abby Bohl, Editor) and eclipse events (me)! It looks like it'll be cloudy for the October 14th annular eclipse, but feel free to join us on the hill outside Fuertes from 12 to 2 PM. We'll have eclipse glasses for viewing the 36% eclipse safely (or save them for the big total eclipse in April)!

Plus, as your resident sharer-of-a-birthday with Carl Sagan, I'm planning some exciting Carl Sagan-related events for the upcoming months. Stay tuned, and stay warm!

Wishing you clear skies,
Gillis Lowry, President

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UPCOMING ECLIPSES AND EVERYTHING YOU NEED TO KNOW ABOUT THEM

BY IONA LESLIE AND TREYTON GRAHN

OCTOBER 2023 ANNULAR ECLIPSE

Eclipses are a phenomenon that have been observed and studied by humans throughout history. From beliefs of supernatural importance to their role in the creation of ancient calendars, we have never stopped loving a good eclipse. On **October 14th**, people across the Americas will have the chance to view an annular eclipse, the last of its kind visible in the United States until 2039, when another annular eclipse will be visible in Alaska.

Annular solar eclipses occur when the Moon passes directly between the Sun and the Earth, specifically at the Moon's furthest point away from Earth. Due to the Moon's distance from the Earth, it appears to be smaller and does not cover the entire Sun as it would during a total eclipse.

Image of eclipse path, taken from NASA's Eclipse Explorer
Credit: [NASA's Scientific Visualization Studio]

Shadow of an Annular Eclipse Seen from the Space Station on May 20, 2012 | Credit: [NASA/Don Pettit]

This specific eclipse will be most visible in Texas. As the Moon passes over the Sun, it will achieve partial eclipse for an hour and twenty minutes leading up to. the point of greatest coverage, which will last up to five minutes. At this time, the Moon will look like a "ring of fire" with the edges of the Sun visible around it.

Those in Ithaca will be viewing around 36% solar coverage. The eclipse will begin at about 12:02 pm, achieve its maximum coverage at 1:15 pm, and end around 2:30 pm. Those viewing from different areas of the country should check to find when the eclipse is happening for them, and you can find that information here.

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APRIL 2024 TOTAL ECLIPSE

While the October eclipse is exciting on its own, there will be an even more impressive total solar eclipse viewable in upstate New York on **April 8th, 2024**. Unlike the upcoming October eclipse, where those viewing in Ithaca will experience about 36% coverage, Ithaca will see nearly complete coverage in April, with the path of totality being a two hour drive north! Totality is a phenomenon that those in the continental United States won't experience again until 2044, so make sure you plan ahead of time for good viewing.

Map of 2024 total eclipse path
Credit: [NASA's Scientific Visualization Studio]

2017 total solar eclipse
Credit: [NASA/Aubrey Gemignani]

IMPORTANT: ECLIPSE SAFETY

When viewing an eclipse, you must take safety measures to ensure a fun and safe viewing experience. Due to the Sun not being fully covered during partial solar eclipses, **never look directly at the Sun without eye protection.** You'll need to wear certified eclipse glasses. Some safety information to keep in mind includes:

- **Sunglasses are NOT a viable alternative to eclipse glasses,** which are at least 1,000 times darker than sunglasses.
- **Buy your eclipse glasses from a reputable source** such as the ones listed here and make sure they're ISO certified.
- **Don't reuse old filters or eclipse glasses**—they can wear out over the years.
- It is also **not safe to use cameras**, binoculars or telescopes to view the eclipse without a solar filter.
- Even if something looks dark, it must be rated for viewing the sun, since incorrect eye protection or **no eye protection will result in serious eye injury**.

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A map showing where the Moon's shadow will cross the U.S. during the 2023 annular solar eclipse and 2024 total solar eclipse.

Credit: [NASA's Scientific Visualization Studio](#)

Even though total eclipses and annular eclipses stem from the same event, total eclipses are a far greater sight! In a total solar eclipse, the moon is large enough to completely cover the Sun, resulting in only the Sun's white outer atmosphere visible. Better yet, the Sun's atmosphere is safe to view with the naked eye! This period of "totality" is the only time it is ever safe to look at any solar eclipse directly, which makes total eclipses an even greater cosmic marvel than annular eclipses.

OCTOBER ECLIPSE VIEWING EVENT

For those on the Cornell campus or in the Ithaca community wishing to view the October annular eclipse, the Cornell Astronomical Society (CAS) is hosting a viewing event on the hill right outside of Fuertes Observatory. CAS will have some eclipse glasses available for a fun and safe viewing of this rare cosmic event.

For more information about the October 2023 annular eclipse click [here](#), and for information about the upcoming total solar eclipse in April 2024 click [here](#).

SCAN FOR BOTH ANNULAR AND TOTAL ECLIPSE INFORMATION:

OSIRIS-REX

BY MARQUICE SANCHEZ-FLEMING

As *autumn* rolls around once more, we welcome a space probe *falling* back to Earth: NASA's OSIRIS-REx, which was launched seven years ago in NASA's first attempt to collect and bring back asteroid samples for scientific research. OSIRIS-REx, whose full name is Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer, is a pioneer of scientific achievement and advancement that set out to unlock the secrets behind the formation of our solar system and the mysteries regarding the rise of organic life.

The sample return capsule from NASA's OSIRIS-REx mission shortly after touching down
Credit: NASA/Keegan Barber

OSIRIS-REx visualization
Credit: NASA's Goddard Space Flight Center

The SamCam imager's field of view as the OSIRIS-REx approached Bennu
Credit: NASA/Goddard/University of Arizona

After launching in 2016, REx entered the orbit of its target in 2018, a near-Earth asteroid named 101955 Bennu. Finally, on October 20, 2020, more than four years after its initial launch, REx finally touched down upon Bennu and began its sample extraction. Now it has almost finished its journey home: 80,810,198 kilometers, two years, and a lonely journey through space, finally touching down upon the surface on Sunday, September 24, 2023.

Bringing back with it at least four-hundred grams of sample material, the mission is an overwhelming success, as initial expectations were slated to extract only sixty grams of material. This sample is more than enough to begin a deep-dive analysis into the explanation of the processes by which life forms.

REx's monumental undertaking has truly taken us on a journey back to our origins: the birth of the solar system. Moreover, while REx's physical expedition ends, the scientific discoveries are limitless. To a new age of discovery, thank you OSIRIS-REx!

MISSION TO PSYCHE

BY CLAIRE CAHILL

After years of development, NASA and Arizona State University's Psyche spacecraft is finally ready to make the six-year, 2.2-billion–mile journey to the Main Belt.

Out of the hundreds of thousands of known asteroids between Mars and Jupiter, what makes 16 Psyche so special? According to the Jet Propulsion Laboratory (JPL), Psyche is rich in metals, consisting of high amounts of nickel, iron, and gold. Scientists believe that it could be the corpse of a rocky planet, much like Earth or Mars, with its metal-rich core exposed.

Metal-rich asteroid Psyche
Credit: NASA

Top: xenon plasma emits a blue glow from an electric Hall thruster identical to those that will propel NASA's Psyche spacecraft to the main asteroid belt. Bottom: a similar non-operating thruster
Credits: NASA/JPL-Caltech

The overarching science goals of the mission include characterizing the metallic cores of early planets. Psyche presents a unique opportunity to look directly into one such core, which, in other bodies in the Solar System, tend to be hidden by thick layers of crust and mantle. It also offers the chance to compare the formation of small bodies with large bodies like our home planet.

Did Psyche and Earth form in similar conditions? Does the metal-rich environment of Psyche's surface look at all like the high-pressure core of the Earth? These are some of the questions that the Psyche mission aims to answer.

The mission will also be launching demonstrations of new engineering that could be integral to higher-budget deep space missions in the future. Much like the Dawn mission to Ceres, Psyche will be making use of xenon ion propul-sion. An ion thruster works by ionizing its propellant with high-energy electrons. This process

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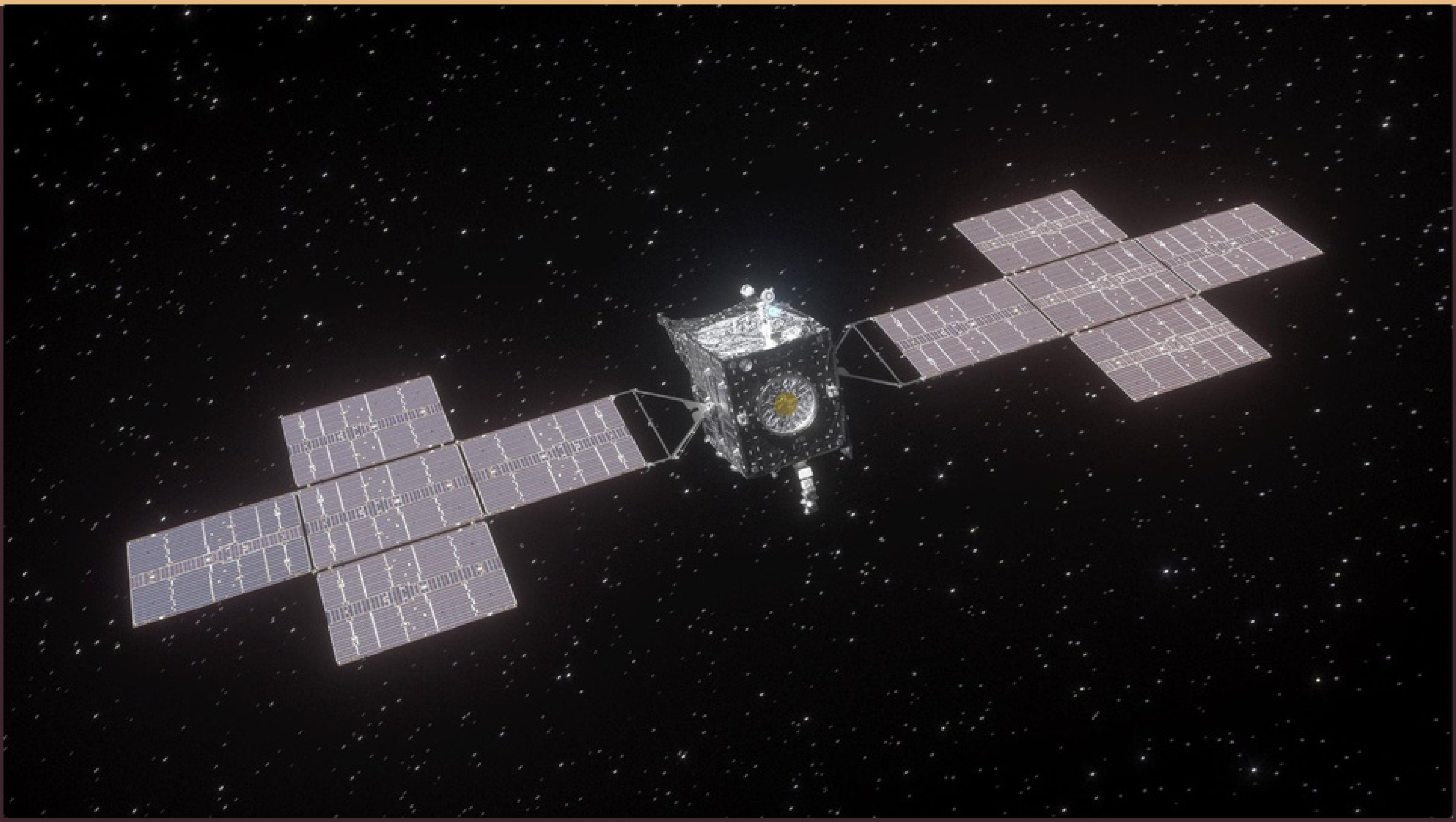


Artist's concept of the Psyche spacecraft with its large solar arrays fully deployed and one of its four Hall-effect thrusters firing (visible via its blue glow) atop the spacecraft's body
Credit: [NASA/JPL-Caltech/ASU]

releases electrons from the xenon pro-pellant atoms, creating positive ions. These ions are then accelerated by a series of electrodes, which allows them to exit the engines at high speeds (~90,000 mph), producing thrust.

Ion propulsion is exciting for the realm of deep space exploration because ion engines have very high specific impulse. Without getting into the gory details of what exactly specific impulse is, the Psyche mission can travel with less fuel on board than would be needed with traditional chemical fuel. Xenon in particular works very well for fuel because its high atomic mass allows it to produce more thrust than smaller atoms.

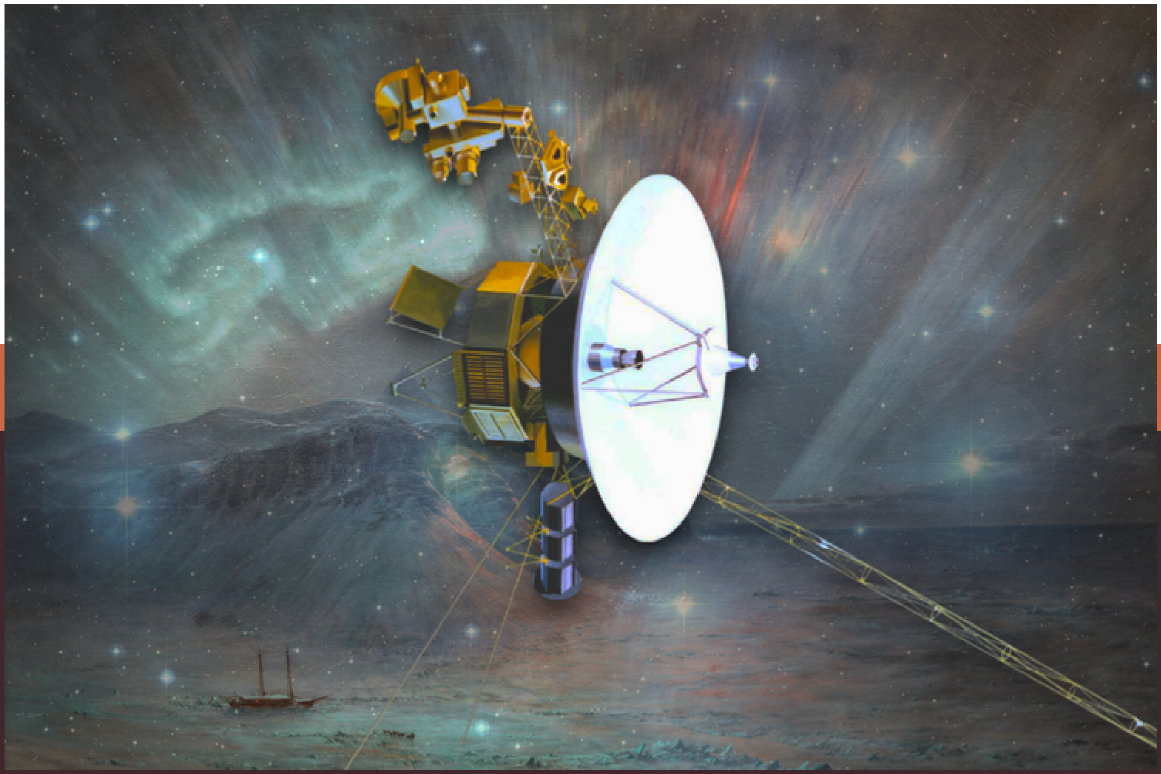
Psyche will also make use of new means of communication. Instead of sending data back to Earth through radio waves like most spacecraft, it instead uses a near-infrared laser. Near-infrared wavelengths of light have a much higher frequency than radio waves, which means that the Psyche mission can send more data back to us in less time.

Psyche was selected as a Discovery class mission in early 2017, and it has been under deve-lopment at ASU and JPL ever since. Originally slated to launch in 2022, Psyche faced delays due to problems with its Guidance, Navigation, and Control (GNC) software, which is integral to the orientation control of the spacecraft and its antenna. Even after the threat of cancellation in September of 2022, the mission is finally ready to launch on October 12th, where it will begin its long journey to the Main Belt. Godspeed, Psyche!

WHEN SPACESHIPS PASS IN THE NIGHT:
EXOPLANETS AND THE SEARCH FOR LIFE

BY GILLIS LOWRY

This piece won 2nd Prize in the Eleventh Annual Joan and Arnold Seidel Griffith Observer Science Writing Contest. The full version can be read in the October issue of the Griffith Observer, or here: www.gillislowry.com/post/when-spaceships-pass-in-the-night



We are surrounded in every human pursuit by the ghosts of those who came before us. Every book we read links to moments past, as does every oil painting and every mark of graffiti along a bridge; every building inhabited before us, built by someone else's hands; every science arising from ancient Greece, ancient Mesopotamia, ancient stories passed down about constellations before humans learned to write.

For a hundred years now, we've broadcast bits of culture over radio waves. We've sent our pop songs, our daytime news, and our nightly television spectacles every which way—including up into space. Past broadcasts bubble out from our planet at the speed of light. Carly Rae Jepsen plays prominently to stars ten lightyears away, while Phil Collins' "In the Air Tonight" now echoes at the star Capella.

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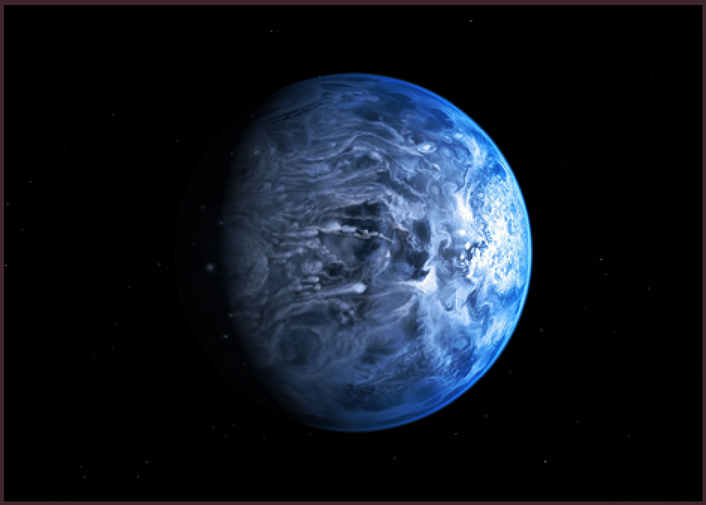
Our broadcasts aren't the only signals marking up the universe. No matter what direction we gaze in the sky, a dim glow rushes back to us over microwaves, a low-intensity form of light. This "cosmic microwave background" is a remnant of the early universe, from around 13.8 billion years ago. But if the universe has been around for billions of years, shouldn't there be more? Shouldn't there be alien broadcasts, alien pop songs—ghostly messages from worlds before ours?

Though the question of whether we're alone has been asked for centuries, we've only started to search in the second half of the 1900s, thanks in part to the late Carl Sagan. As a science popularizer, Sagan worked to dispel UFO myths and create interstellar greetings to potential aliens. As an astrophysicist, he explored the possibility of life on Mars, Venus, and the moons of Jupiter and Saturn, as well as life on "exoplanets," worlds that orbit other stars. We haven't found evidence of life on these planets yet—but the search has barely begun.

Although Carl Sagan died in 1996, just four years after the first exoplanets were discovered, his vision of finding life in the universe carries on at Cornell University's Carl Sagan Institute. Because the search for life bridges many different fields, the Institute attracts members from across biology, Earth science, computer science, math, engineering, and even English.

Dr. Lisa Kaltenegger is the director of the Carl Sagan Institute. She and her team create computer models of exoplanets—some hypothetical and some real—to find out if life on another planet could produce signs we might detect on Earth. All it takes is a little starlight.



Artist's conception of exoplanet HD 189733 b, a deep blue dot where glass may rain sideways. Its color comes from clouds of silicate particles, whipped up above winds over 5,000 miles per hour
Credit: ESO/M. Kornmesser

When an exoplanet passes in front of its host star, it blocks a bit of the star from view, causing telescopes to record a dip in starlight. Some of the starlight that reaches Earth also passes through any atmosphere the exoplanet has. When scientists examine this light, they're able to deduce what elements it en-countered on the way, forming a luminous fingerprint of the planet's atmosphere. Scien-tists call this fingerprint the planet's "spectra."

"Specifically, my team's research is modeling the spectra of Earth-like planets around other stars," Dr. Kaltenegger says. "If there were life—and it could be a very different kind of life on that planet—would it look different from an inhospitable world to our telescopes?"

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Artist's conception of the surface of Proxima b, a "habitable zone" planet that could have liquid water on its surface. Proxima b orbits the nearest star to Earth, a red dwarf named Proxima Centauri. Alpha Centauri A and B can be seen as two tiny dots to the right of Proxima Centauri, forming the rest of this planet's triple star system
Image Credit: ESO/M. Kornmesser

Dr. Kaltenegger marvels at the perspective young adults and children seem to have regarding life on other worlds. "A lot of people actually assume there is life already," she says. The first exoplanet around a Sun-like star was confirmed in 1995, and people born after this date "have never lived in a world where we didn't know for sure there were other planets.... Is it really such a jump to say, if there are other planets, if they're the right distance, if they're the right size, some of them must have life?"

After 13.8 billion years, with an estimated 300 million planets able to support life in the Milky Way, it seems impossible for us to be the first.

Or maybe we're afraid to be alone.

Read the rest at gillislowry.com/post/when-spaceships-pass-in-the-night:

LIFE CYCLE OF STARS

BY DYLAN JACKAWAY

How do stars work? How does the Sun compare to other stars? And what happens to them as they move through the various phases of their life cycle?

For millennia, many believed that the Sun had to be made of some kind of fire. A few people, like Italian philosopher Giordano Bruno, realized that the stars in the sky were just like the Sun, merely viewed from far away, but we still didn't know what they fundamentally were. It was only with Einstein around the early 20th century that the process by which stars generate light was uncovered.

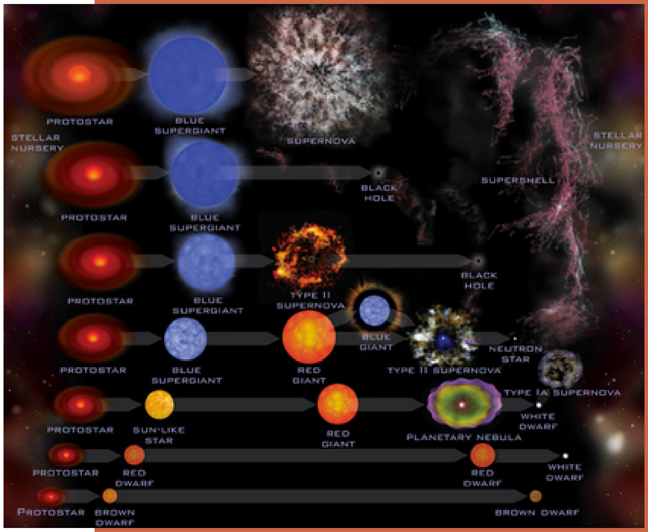

Diagram of stellar evolution
View the full size at NASA/JPL

Image of AFGL 5180, a stellar nursery located in the constellation of Gemini
Credit: ESA/Hubble & NASA, J. C. Tan (Chalmers University & University of Virginia), R. Fedriani (Chalmers University); Acknowledgment: Judy Schmidt

Stars form when clouds of gas, mostly hydrogen (the simplest element), contract under their own gravity. This contraction generates heat and pressure, which causes the atoms within the gas to bump up against one another. Once the atoms come within a certain tiny distance from each other, the strong nuclear force takes over and causes the nuclei to snap together, overcoming the electro-magnetic repulsion of the positively charged nuclei and releasing the energy associated with this repulsion. This heats up the stellar interior further, halting the gravi-tational collapse, and a chain reaction begins, fusing hydrogen into helium.

What happens next depends on the mass of the star. For low-mass stars, or red dwarfs, this chain reaction can continue undisturbed for upwards of a trillion years (much longer than the current age of the universe), before gra-dually fizzling out and leaving behind an inert ball of helium known as a white dwarf. (For objects with even less initial mass, nuclear fusion actually does not produce enough energy to stop the star from cooling down. Therefore, within a few million years, the core is no longer hot enough to keep the fusion going, leaving behind what is essentially a large gas giant planet known as a brown dwarf.)

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For more massive stars like the Sun, hydrogen fuses more quickly, due to the higher temperature and weight pressing on the core, and is exhausted after about ten billion years. At this point, gravity briefly causes the star to contract. However, this quickly generates enough heat and pressure for the core, now full of helium, to undergo nuclear fusion again. This time, it produces carbon and oxygen, causing the star's luminosity to skyrocket and its outer layers to balloon outwards to hundreds of times their original size.

Such an expansion cools down the outer layers of the star, causing them to glow red, which is why this stage is known as the red giant phase. At this point, the Sun's gravity will be too weak to hold onto its outer layers, and just under half the Sun's mass will ultimately escape into space, creating a planetary nebula, and leaving behind a white dwarf where its core was.

An infrared photo of a famous planetary nebula, the Ring Nebula. Planetary nebulae are so named for their superficial resemblance to a planet
Credit: [NASA, ESA, CSA, JWST; Zi Yang Kong]

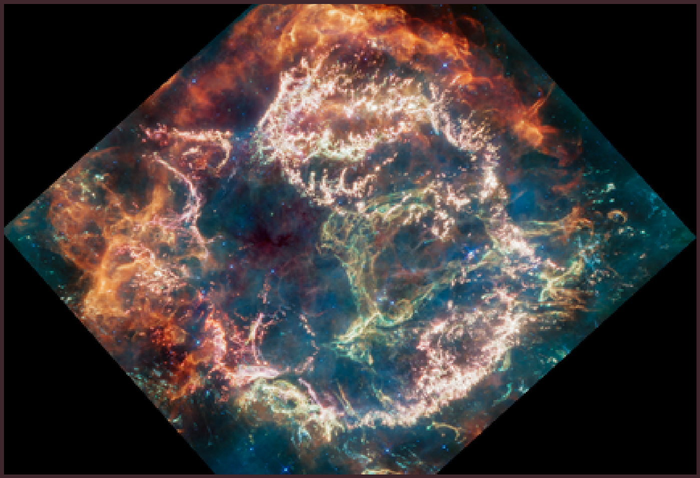

Image of the supernova remnant, Cassiopeia A
[Credit: NASA, ESA, CSA, Danny Milisavljevic (Purdue University), Tea Temim (Princeton University), Ilse De Looze (UGent)]

For even more massive stars, between 8–40 times the mass of the Sun, the cycle of contraction and expansion continues, and carbon and oxygen fuse into heavier elements, such as neon, silicon, and eventually iron. It takes only millions, not billions, of years to reach this point, but this is the end of the line, since fusing iron into heavier elements actually consumes more energy than it releases.

Eventually, the stellar core, with as much mass as the Sun, collapses to the size of a city in a fraction of a second, releasing a tsunami of gravitational potential energy that blasts the rest of the star apart in a supernova explosion. Some of this energy also goes into fusing elements above iron.

Such events are estimated to take place about once or twice per century in our galaxy, and when they do, they outshine the entire galaxy for about a month. It's thought that the star Betelgeuse in the constellation Orion will go supernova anytime between ten years and ten thousand years from now, a blink of an eye on cosmic timescales.

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During the stellar core collapse, iron is compressed with such force that the negatively-charged electrons floating around merge with the positively-charged protons in the atomic nuclei to form neutrons. The resulting "neutronium" is so dense that one teaspoon of it would weigh as much as Mt. Everest, and the entire leftover neutron star can be said to be one giant atomic nucleus.

Inheriting the angular momentum of the pre-collapse star, neutron stars can rotate at up to a thousand times per second, generating the strongest known magnetic fields in the universe. When these magnetic fields happen to be aimed at Earth, we see an almost perfectly repeating burst of radio waves, as accurate as our best atomic clocks. These objects are therefore also known as pulsars.

Image of the Vela pulsar wind nebula. Light blue represents X-ray polarization data from NASA's Imaging X-ray Polarimetry Explorer. Pink and purple colors correspond to data from NASA's Chandra X-Ray observatory. NASA's Hubble Space Telescope contributed the stars in the background
Credit: X-ray: (IXPE) NASA/MSFC/Fei Xie & (Chandra) NASA/CXC/SAO; Optical: NASA/STScI; Judy Schmidt, Kimberly Arcand & Nancy Wolk

However, with some stellar cores, gravity overcomes even the tendency of neutrons to avoid taking up the same space as one another. These (theoretically) collapse all the way to a single point, forming an object known as a black hole, given that at a certain distance from them (the event horizon), even light is too slow to escape their pull. For massive enough stars, the pull of this black hole is strong enough to overcome the outward force of the supernova explosion.

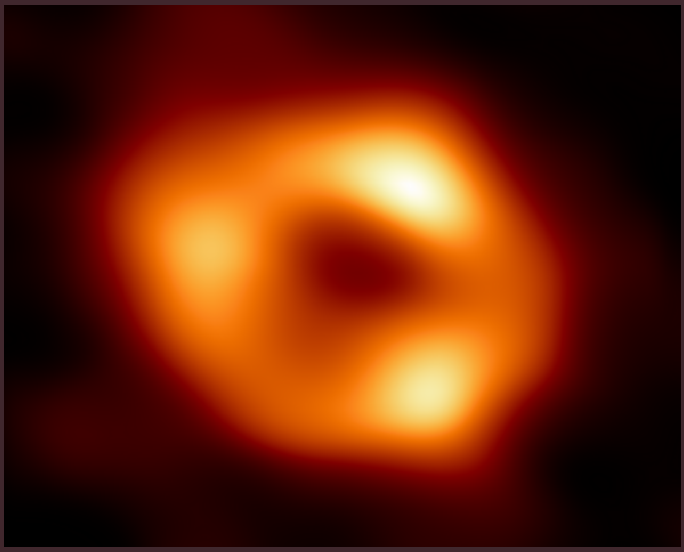


*Image of the black hole at the center of our Milky Way, Sagittarius A** | Credit: EHT

Finally, the most massive stars, weighing in at over 130 Suns, can actually produce so much energy during a moment of contraction that they actually explode right then, leaving behind no remnant object at all. However, these stars are extraordinarily rare.

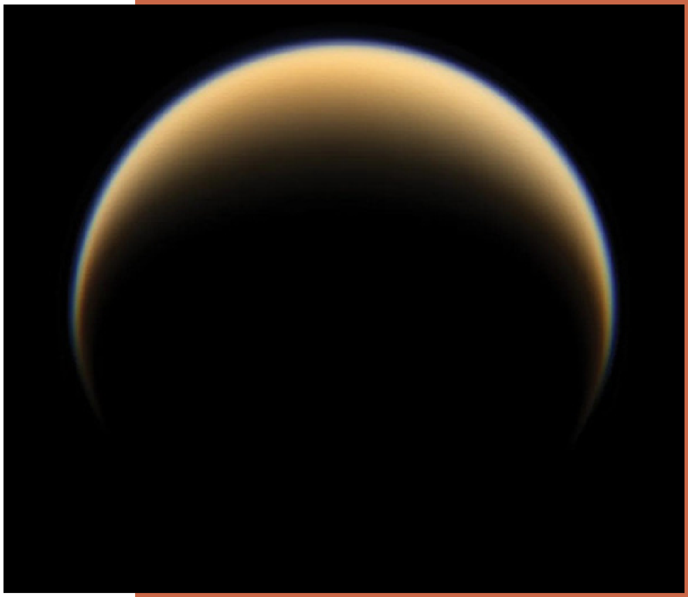
Given that all matter that we encounter on Earth was created in a star or a supernova, the well-known saying that "we are star stuff" is true in the most literal sense. Next time you go stargazing or look at the Sun (indirectly, of course), take a moment to remember the role that these cosmic furnaces play in building the universe that we know today.

TITAN

BY JUSTINE SINGLETON

Picture this: It is raining. You have to go outside, so you grab your raincoat or umbrella and brave the weather.

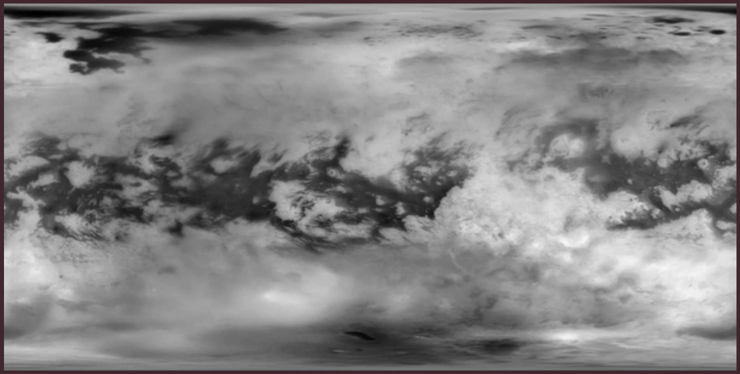
Beneath your feet, the sidewalk glistens from the rain. It reminds you of Saturn's moon Titan. Back in 2019, scientists confirmed it was raining on Titan because of light reflected from its surface, which is called the "wet sidewalk effect". You imagine yourself on the Saturnian moon, the only other known place in the Solar System to have a kind of water cycle. Except it doesn't rain water on Titan. Instead, it rains liquid methane.



The Cassini spacecraft looks down on the north pole of Titan
Credit: NASA/JPL-Caltech/SSI

Walking on Titan, you would see a world not unlike Earth, with lakes, rivers, and seas scattered across the surface—only filled with methane and ethane. Temperatures are so far below freezing that any water on Titan's surface is rock solid. Depending on which side of the moon you stand on, the waterways (so to speak) would look completely different. On the western side of the northern hemisphere, there are mainly small lakes on top of hills, but the eastern side has seas on lower, flatter terrain. Additionally, the northern hemi-sphere lakes have more methane than those in the southern hemisphere.

As the rain gets heavier back on Earth, puddles start to form. You slosh through the rippling water. The puddles seem to get larger and deeper the further you walk, and you recall the depths of Titan's lakes and seas. Kraken Mare (pronounced "MAH-ray") is the largest sea, over 1000 feet deep and as wide as all five Great Lakes put together.



A global mosaic of Titan's surface brightness in the near-infrared at 938 nm wavelength, showing the distribution of Titan's wide variety of landforms, from the vast equatorial sand seas to the high-latitude lakes and seas of liquid hydrocarbons
Credit: NASA, ESA, and the Italian Space Agency

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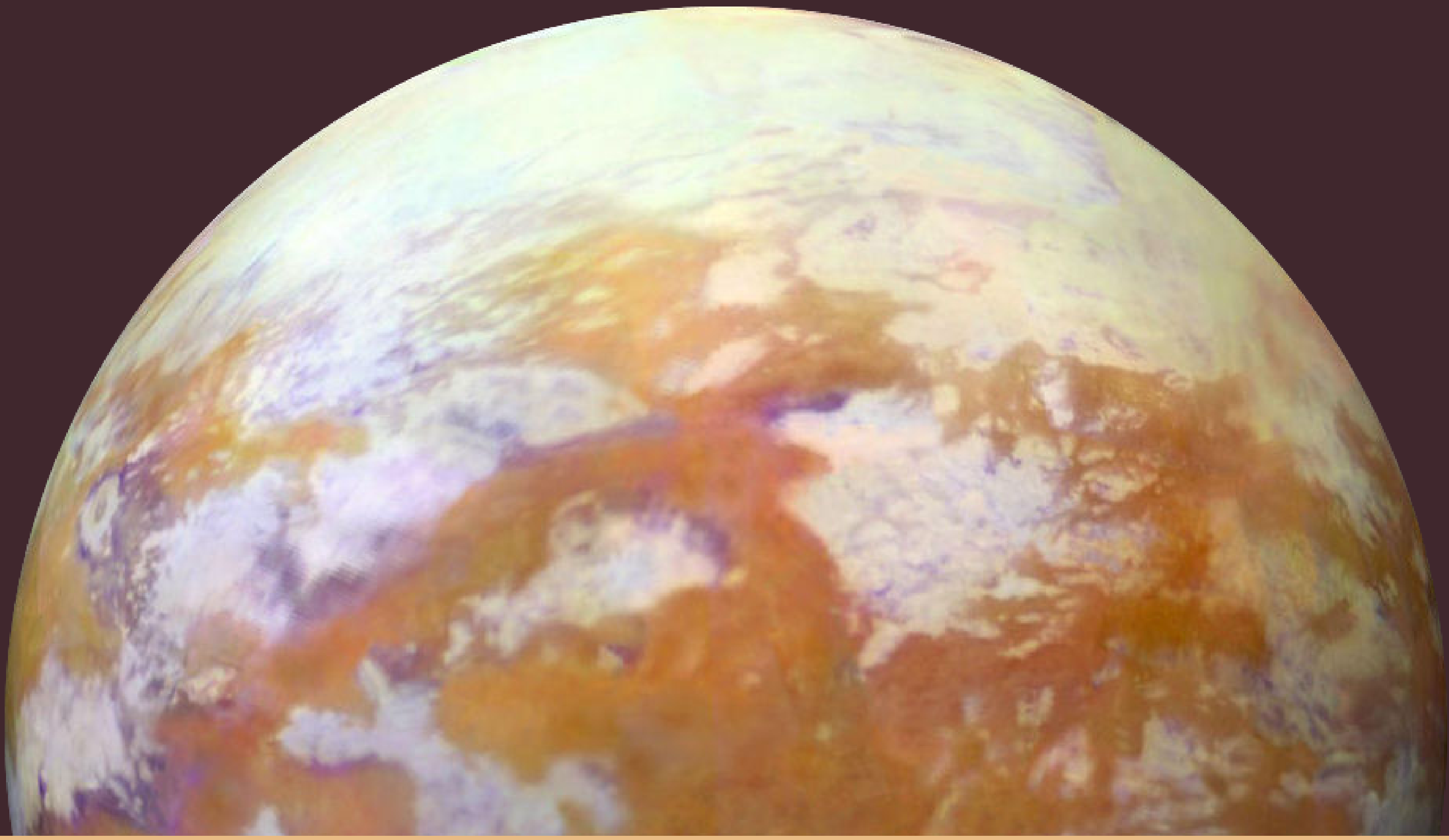
These lakes and seas are also incredibly still, unlike the puddles rippling from your footsteps. Waves detected on Titan have been miniscule, and studies suggest they can only physically reach about 20 centimeters high. However, these bodies are not perfectly calm. Many Titanian lakes contain bubbles from fizzing nitrogen. This is especially noticeable in Titan's second largest sea, Ligeia Mare, which had large enough clusters of bubbles that scientists mistook them for an island.

Cars zip past on the wet streets, splashing you and any other passersby. Titan, at least, has no cars to splash you, and less rain than Earth. Some locations on the Saturnian moon wait centuries between rainfalls. At the north pole, it rains when spring changes into summer. But seasons on Titan last seven years. You try to imagine waiting seven years for autumn leaves to fall, seven years for the first winter snow, seven years for the blossoms of spring, seven years for summer heat. It's almost unthinkable.

Finally, you arrive at your destination. You leave the rain behind you, knowing it will end soon enough. And Earth's autumn will begin with its familiar red and gold.



MAPPING OUR GALAXY LIKE NEVER BEFORE: ICECUBE'S MILKY WAY NEUTRINO MAP

BY NICHOLAS VASILESCU

This past summer, astrophysicists mapped our Milky Way using particles a million times less massive than electrons—particles that pass through our bodies 100 trillion times per second—called neutrinos. While astrophysicists have produced images of our galaxy using optical and even gamma rays before, they have never done so using neutrinos because of how difficult it is to detect them.

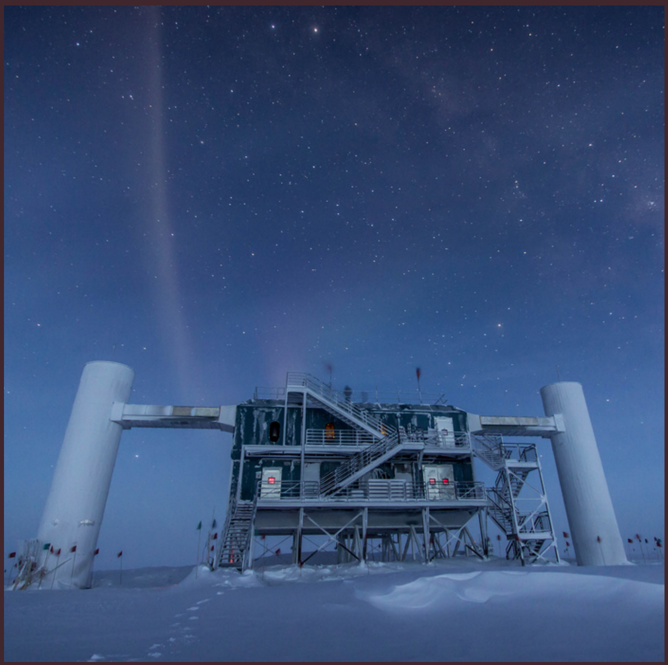


Image of the IceCube Laboratory at the Amundsen-Scott South Pole Station, in Antarctica
Credit: [Felipe Pedreros, IceCube/NSF]

In order to detect these tiny particles, the IceCube Neutrino Observatory was completed in December 2010. It takes a cubic kilometer of space 1,500 meters underneath the South Pole in order to shield the neutrino detector from natural radiation at the Earth's surface. IceCube is composed of over 5,000 digital optical module (DOM) sensors distributed across 86 kilometer-long DOMs.

While the ice shields the detector from natural radiation, the instrumented ice volume also functions as a medium for neutrino interactions; charged particles are created when neutrinos interact with ice nuclei. These interactions are called "cascade events" because of the speed at which neutrinos arrive and interact with nuclei. This process creates ultraviolet and blue light called Cherenkov radiation, which is detected by IceCube's DOM sensors.

IceCube has allowed neutrinos to be detected on a large scale, having detected at least 900,000. With IceCube's capability, astrophysicists hypothesized that neutrinos could be used to map the galaxy, since "gamma ray observations show bright emission from within the

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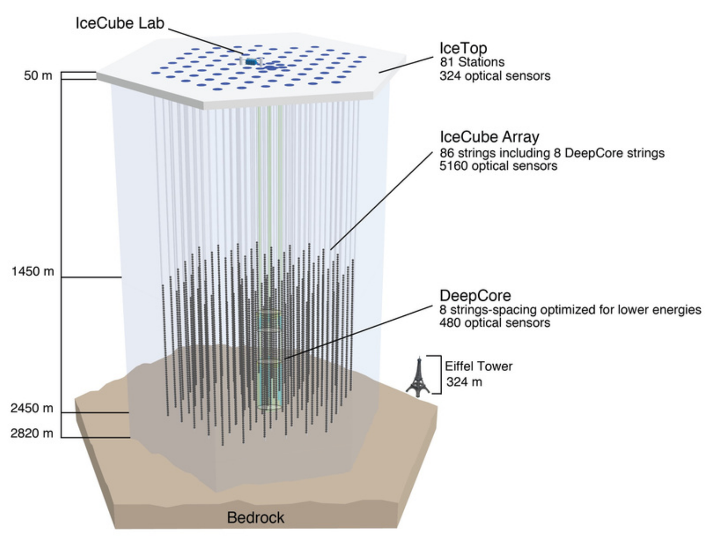


Diagram of IceCube Neutrino Observatory instruments
[Credit: IceCube Collaboration]

Milky Way galaxy, and astrophysical gamma rays and neutrinos are expected to be produced by the same physical processes," according to Keith T. Smith, an editor for *Science*. Specifically, Smith refers to the idea of neutrinos tracing back to gamma ray bursts (GRBs).

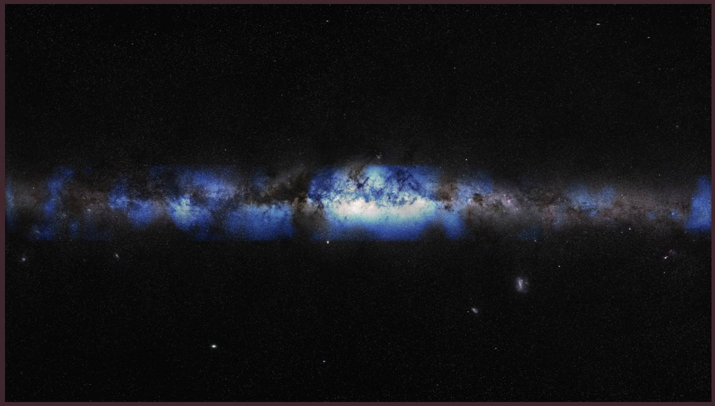
The black hole or neutron star created in a GRB event collapses or merges with another object, which emits jets of accelerated gas. The electrons in these jets then emit gamma rays, the highest frequency form of light. These gamma rays are also called synchrotron radiation, and they interact with protons to create neutrinos.

As a result, bright gamma ray emissions within the Milky Way are potentially sources of an abundance of neutrinos. According to the paper published in the journal, Science, IceCube is able to trace the locations of neutrinos "because of the large momentum transfer from the incoming neutrino[s]" on the ice, aligned with the direction the neutrinos came from.

The IceCube Collaboration team, led by Professor Francis Halzen, used deep learning, specifically convolutional neural networks (CNNs), to reconstruct the chain reactions caused by neutrinos in the ice. The use of a CNN allowed the researchers to be more precise with their data collection, detecting lower energy astro-neutrino events while background neutrino events that did not originate in space were rejected.

The team used their deep learning model to plot the average energy values of neutrinos detected in the southern sky, as well as the number of expected neutrino detections per year. These plots show where neutrinos originated and how energetic their cascade events were. Because neutrinos and gamma rays can come from the same physical processes, the plots also reveal where there are potentially strong gamma ray sources.

IceCube revealed that our galaxy has an abundance of high-energy neutrino sources. Additionally, the neutrino map produced with IceCube data is another reminder of the increasing role machine learning plays in astronomy. With the help of observatories like IceCube and computer programs to sort data by the thousands we have begun to see our universe more clearly than ever.



The Milky Way seen through a neutrino lens (blue)
Credit: [IceCube Collaboration/U.S. NSF (Lily Le & Shawn Johnson)/ESO (S. Brunier)]

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Source for Title Page Image

Image

Sources for "Upcoming Eclipses and Everything You Need To Know About Them":

1 - 2 - 3 - 4

Sources for "Mission to Psyche":

1 - 2 - 3 - 4

Sources for "Titan":

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Image

Cornell Astronomical Society (CAS) is a student-run non-profit organization founded in 1972.

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