ECLIPSE
NEWSLETTER

The Eclipse Newsletter is by-monthly newsletter dedicated to increasing the reader's knowledge of Astronomy, Astrophysics, Cosmology and related subjects.

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CONTENTS:

ASTRONOMICAL TERMS AND NAMES DEFINED:

I offer this so those who are new to the subject matter offered will have a better chance of understand certain names as well as terms used in these articles.

Equinox - the time or date (twice each year) at which the sun crosses the celestial equator, when day and night are of equal length (about September 22 and March 20).

Polaris - A star located at the end of the handle of the Little Dipper, in the constellation Ursa Minor, approximately 408 light years from Earth, and almost at the north celestial pole. Also called North Star, polar star, polestar.

polarization degree - Degree of polarization (DOP) is a quantity used to describe the portion of an electromagnetic wave which is polarized. A perfectly polarized wave has a DOP of 100%, whereas an unpolarized wave has a DOP of 0%

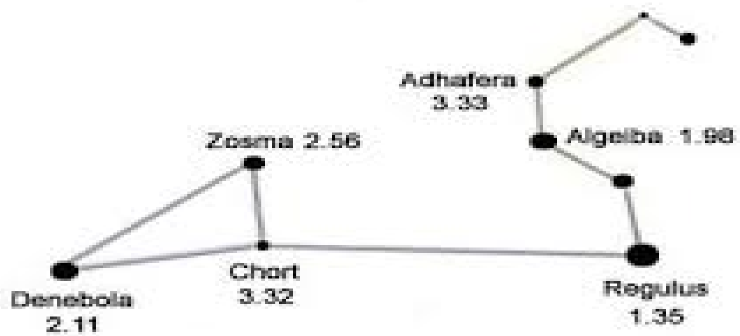
planetary volcanism - Volcanism is the eruption of molten rock (magma) onto the surface of a planet. A volcano is the vent through which magma and gases are discharged. Magma that reaches the surface is called "lava." Volcanos are named for Vulcan — the Roman god of fire!

fluvial and aeolian processes - Fluvial is a term used in geography and geology to refer to the processes associated with rivers and streams and the deposits and landforms created by them. When the stream or rivers are associated with glaciers, ice sheets, or ice caps, the term glaciofluvial or fluvioglacial is used. Aeolian

processes, also spelled eolian or æolian, pertain to wind activity in the study of geology and weather and specifically to the wind's ability to shape the surface of the Earth (or other planets).

Kuiper Belt - Sometimes called the Edgeworth–Kuiper belt, is a circumstellar disc in the Solar System beyond the planets, extending from the orbit of Neptune (at 30 AU) to approximately 50 AU from the Sun. It is similar to the asteroid belt, but it is far larger—20 times as wide and 20 to 200 times as massive. Like the asteroid belt, it consists mainly of small bodies, or remnants from the Solar System's formation. Although many asteroids are composed primarily of rock and metal, most Kuiper belt objects are composed largely of frozen volatiles (termed "ices"), such as methane, ammonia and water. The Kuiper belt is home to three officially recognized dwarf planets: Pluto, Haumea, and Makemake. Some of the Solar System's moons, such as Neptune's Triton and Saturn's Phoebe, are also thought to have originated in the region.

CONSTELLATION LEO



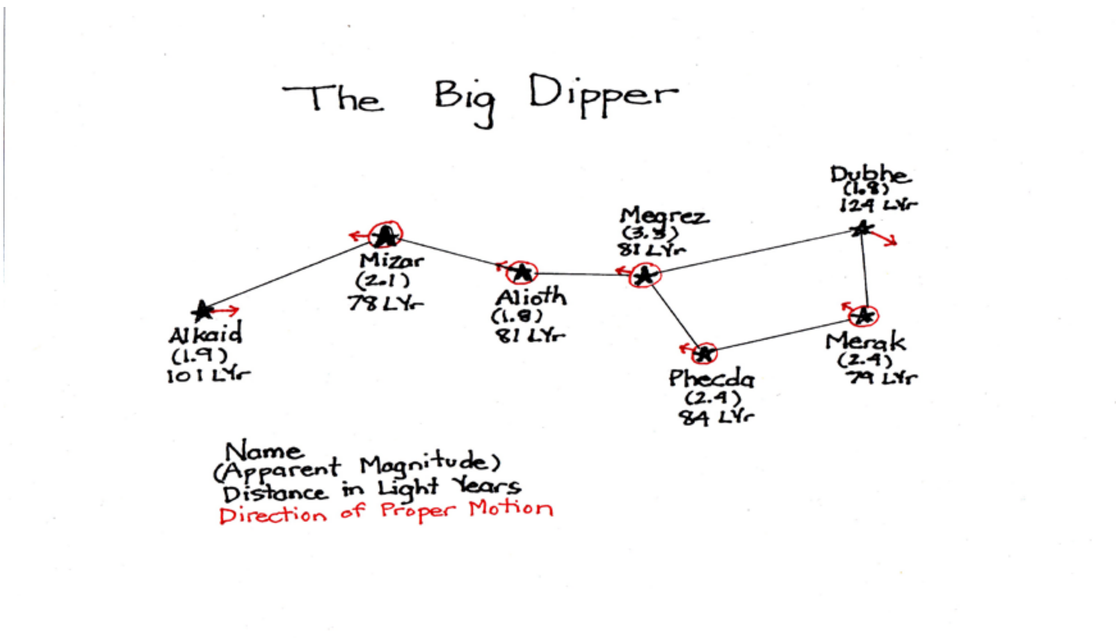
Of the 13 constellations of the Zodiac, Leo the Lion ranks as one of easiest to identify in the night sky. Most people find Leo by looking first for a distinctive pattern on the sky's dome: the pattern of a *backwards question mark*. That star pattern – or *asterism* – is called *the Sickle in Leo*. Leo's brightest star, Regulus, marks the bottom of the backwards question mark pattern. Follow the links below to learn more about the constellation Leo.

How to see the constellation Leo. From a Northern Hemisphere perspective, the Lion is a fair-weather friend, springing into the early evening sky around the March 20 equinox. Late March, April and May are superb months for identifying Leo the Lion, as this constellation becomes visible as soon as darkness falls and stays out until the wee hours of the morning. Remember, you are looking for a backwards question mark pattern. This pattern is *the Sickle*; its curve outlines the Lion's mane. Leo's brightest star, Regulus, is a sparkling blue-white beauty of a star. It's located at the bottom of the backwards question mark pattern and depicts *the Lion's heart*.

A triangle of stars in eastern Leo represents the Lion's hindquarters and tail. The brightest star of the triangle is named Denebola, which stems from an Arabic term meaning *the Lion's Tail*.

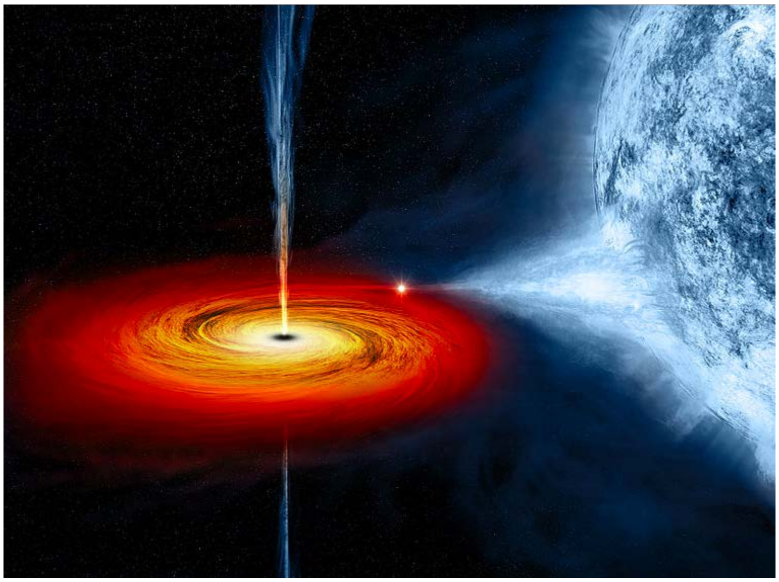
Like all stars, Leo's stars return to the same place in the sky some four minutes earlier daily or two hours earlier monthly. In early April, the constellation Leo reaches its high point for the night around 10 p.m. local time (11 p.m. local daylight saving time), and starts to sink below the western horizon around 4 a.m. local time (5 a.m. local daylight saving time). By around May 1, Leo reaches his high point for the night around 8 p.m. local time (9 p.m. local daylight saving time). Also, in early May, the mighty Lion begins to set in the west around 2 a.m. local time (3 a.m. daylight saving time). By June, you'll find Leo descending in the west in the evening.

Though Leo drifts progressively westward in the early evening sky as the months go by, the Lion can be viewed in the evening till July. By late July or early August, the Lion begins to fade into the sunset, not to return to the eastern predawn sky until late September or October.



Find Leo by star-hopping from the Big Dipper. If you're familiar with the Big Dipper asterism, you can star-hop to Leo the Lion every time. To find Leo, first find the Big Dipper. In March, the Big Dipper stands pretty much on its handle in the northeast sky at nightfall. At nightfall in April, look for the Big Dipper higher in the northeast sky, and at nightfall in May, look for the upside-down Big Dipper high in the north, above Polaris, the North Star. Then identify the two pointer stars of the Big Dipper – that is, the two outer stars in the Big Dipper's bowl. An imaginary line drawn between these stars points in one direction toward Polaris, the North Star. And it points in the opposite direction toward Leo.

Astronomers discovered a rogue, wandering black hole hiding in our galaxy — and it's one of millions.



Black holes may be one of the most terrifying things in existence: A region of space-time where matter is squeezed together so tight, it has a gravitational pull so strong that nothing can escape from it, not even light.

Of the hundreds of millions (perhaps billions) of black holes scientists suspect are floating around in our galaxy, only about 60 have been found. The closest black hole that we know of is around 3,000 light-years away.

But astronomers believe they've spotted a rogue black hole hidden within a fast-moving cosmic cloud tucked away in a corner of the Milky Way. And they think the new discovery could help know where more of them are lurking.

"We found a new way of discovering stray black holes," said Professor Tomoharu Oka, an Astrophysics professor at Keio University and author of the study in a statement.

Their study, published in The Astrophysical Journal Letters, was performed using the ASTE Telescope in Chile and the 45-m Radio Telescope at Nobeyama Radio Observatory. The team observed molecular clouds around the remnant of a supernova explosion called SNR W44, which is about 10,000 light-years away. But inside the cosmic cloud, which is about two light-years in diameter, they found something intriguing: A black hole.

They named the cloud "the Bullet" because it has a speed of over 100 km per second, which is nearly 300 times the speed of sound in space. It was also moving in an unusual way, and wasn't behaving the way they expected.

Most of the Bullet was moving at a speed of about 50 kilometers per second, but the tip was a lot faster. It also appeared to contain tens times the energy it would have received from the W44 supernova. According to Masaya Yamada, a graduate student at Keio University in Japan and leader of the research, this would be impossible under normal conditions.

The team concluded that there were two explanations, both of which involve a strong gravity source, most likely a black hole. With the current data they have, the researchers say both scenarios are equally likely.

1. **The "explosion model" — The gas shell of the supernova remnant passed by a black hole, creating an explosion. This would accelerate the gas toward us after the gas shell has passed the black hole.**
2. **The "shooting model" — A high speed black hole stormed through the gas and dragged it along by the strong gravity of the black hole to form a gas stream.**

Why are black holes so hard to find?

Black holes are often created when a lot of matter is compressed into a small space, which can happen when stars are dying and collapse in on themselves. This means the gravitational pull is so strong, light cannot escape. When no light can get out, that means there's nothing to see, which is why black holes are invisible.

You would be able to tell if a black hole was nearby, because when they are close enough, you would see the background getting distorted. However, by that point it's already too late for you.

It sounds scary, but we have luck on our side. According to NASA, no black hole is close enough to our solar system for Earth to fall into a black hole, and in 4.5 billion years of our existence we've never encountered one.

So we probably won't meet a black hole for billions or trillions of years, if ever. Even if a black hole the size of the Sun sucked up our light source, it would have the same gravitational pull, and thus Earth and the other planets would just orbit it like they orbit the Sun now. So relax.

Extreme Astronomy Unlocks Cosmic Secrets From the South Pole.

Imagine doing astronomy where grease won't stay greasy, where it's nighttime all day during the winter, and where nighttime temperatures fall to -100 Fahrenheit. Well, there's a hardy group of astronomers that enthusiastically do that, year-in, year-out, at Antarctica's South Pole Telescope.

The South Pole is a harsh environment, but it's excellent for astronomy due to its dry atmosphere (water vapor interferes with observations). Researchers at the Harvard Smithsonian Center for Astrophysics are even considering building a telescope at a site called Dome A, about 1,000 miles from the pole and a long trek from habitation.

What is it really like to work down there for up to a year, which is the typical over-winter stay of Antarctic personnel? According to University of Toronto experimental cosmologist Keith Vanderlinde, who spent 11 months there over the winter, it attracts a certain type of person who doesn't necessarily need the company of other people to work well. His group vacillated between being super-social in shared quarters, and choosing to retreat individually to their own quarters. He also saw people "going toasty" (this Antarctic slang for changed behavior comes from bread turning into toast) as they grappled with months of isolation away from families.

"People who didn't work outside at all, they got toasty very quickly. You develop a short fuse," Vanderlinde told Seeker. "People develop a 1,000-mile stare and stare at the wall for an hour and not do anything."

Vanderlinde came to the National Science Foundation-funded South Pole Telescope in 2008 after his Ph.D., when the facility was just in its second year of operations. It was a half-hour trek from the living quarters to the telescope, where Vanderlinde and a colleague checked in to make sure the telescope was staying healthy. Overall the work went well, except for occasional mechanical issues. He recalled, for example, one time when the power went out on a Sunday night, which required a long warm-up procedure that Monday to get the telescope up and running again.

The conditions are harsh, but Vanderlinde says the science is worth it. The telescope is mapping out the cosmic microwave background (CMB), which is the leftover energy from when the universe was first expanding. It can best be seen in microwave wavelengths. As the CMB shines through galaxy clusters, Vanderlinde says, some light scatters off hot electrons and can show up as an excess of energy.

"By looking at these little shadows, you can figure out where all of the largest structures in the universe are," he said. Over time and with observations from the South Pole Telescope's first camera, he said, scientists can also learn how galaxy clusters grew in different eras of the universe, and how dark energy — the ill-understood force that is causing the universe's expansion to accelerate — works.

The second-generation camera on the South Pole Telescope measures the intensity of the light and polarization, or how light is oriented related to the direction where it came from. As the CMB is lensed through galaxies and other structures, scientists can measure how large clumps of matter form over time, which in turn tells them how gravity works. Oddly, he said, tiny particles called neutrinos significantly impact how structure forms in the universe, and how gravity pulls gas and dust together into clusters and galaxies. So by looking at the big scale, scientists can better constrain how massive neutrinos are.

In 2014, another South Pole telescope called BICEP2 detected polarization modes (known as B modes) that were originally interpreted as gravitational waves, or ripples in space-time that form from gravitational interactions. However, further study revealed a more mundane explanation: the polarization came from dust in our own galaxy.

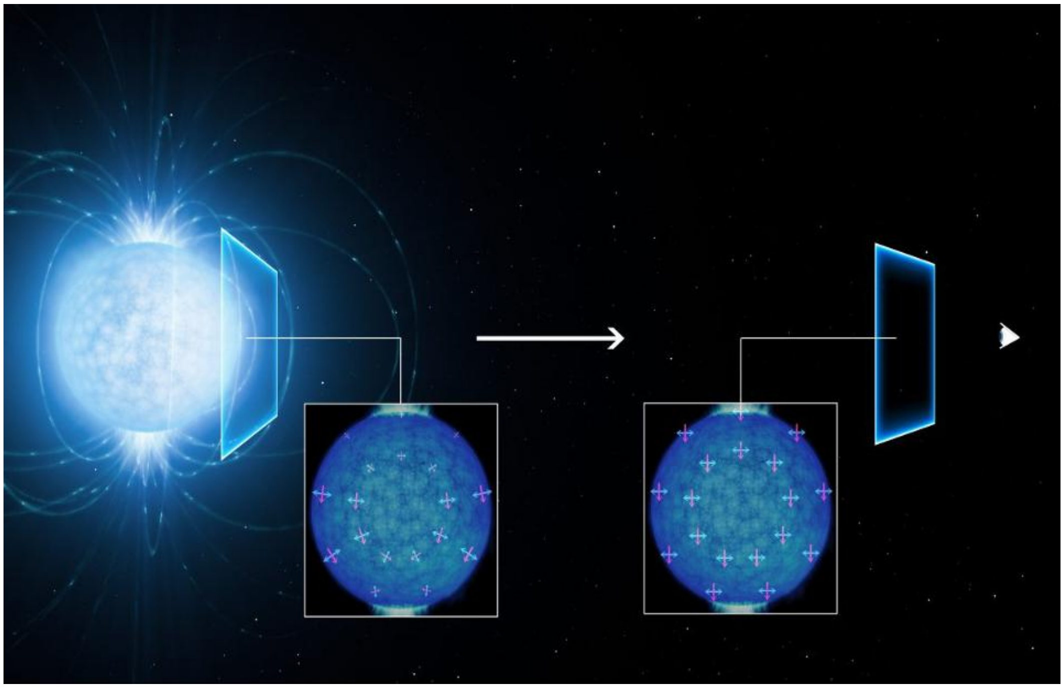
Would Vanderlinde over-winter again? He's made several summer visits since then, but he said once was enough. "After I left I had recurring nightmares that I went back for another winter," he said. "It was not in any way a bad experience, but at the end you're done ... and the idea of doing it again didn't appeal to me."

Credit Elizabeth Howell, Seeker @ Space.com

Heisenberg's Astrophysics Prediction Finally Confirmed After 80 Years.

From Starts With A Bang

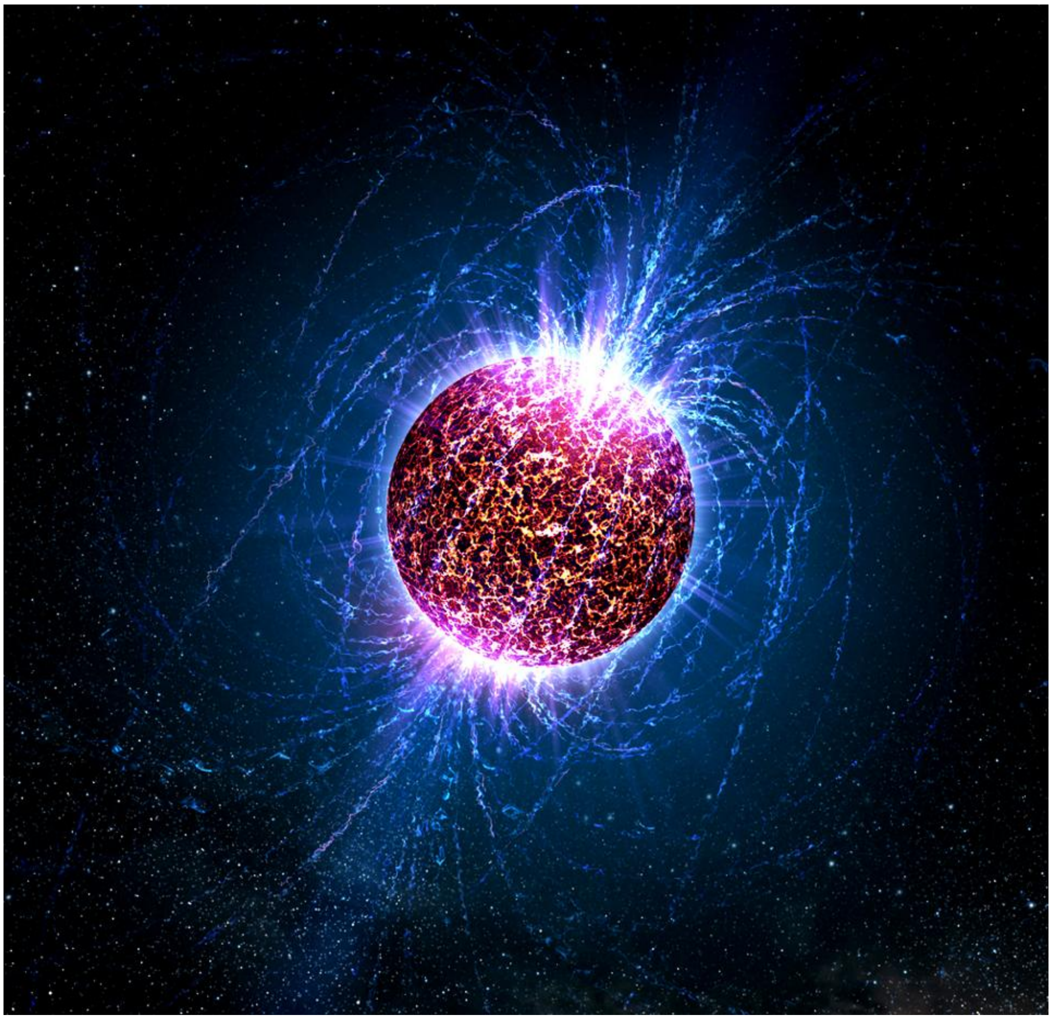
***Ethan Siegel*, Contributor**



Light coming from the surface of a neutron star can be polarized by the strong magnetic field it passes through, thanks to the phenomenon of vacuum birefringence. Detectors here on Earth can measure the effective rotation of the polarized light. Image credit: ESO/L. Calçada.

Discovering that our Universe was quantum in nature brought with it a lot of unintuitive consequences. The better you measured a particle's position, the more fundamentally indeterminate its momentum was. The shorter an unstable particle

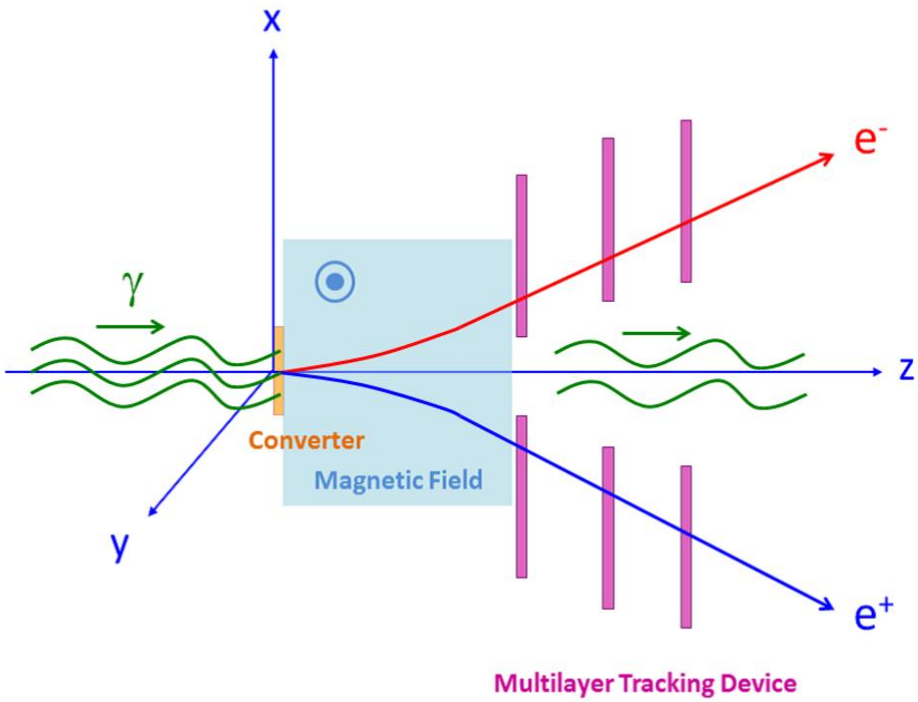
lived, the less well-known its mass fundamentally was. Solid, material objects exhibit wave-like properties. And perhaps most puzzlingly of all, empty space -- space that's had all of its matter and radiation removed -- isn't empty, but is rather filled with virtual pairs of particles and antiparticles. 80 years ago, physicist Werner Heisenberg (who determined the two fundamental uncertainty relations), along with Hans Euler, predicted that because of these virtual particles, strong magnetic fields should affect how light propagates through a vacuum. Thanks to neutron star astronomy, that prediction has just been confirmed.



A neutron star, despite being mostly made of neutral particles, produces the strongest magnetic fields in the Universe. Image credit: NASA / Casey Reed - Penn State University.

We might take the name "neutron star" quite literally, and assume that it's made out of neutrons exclusively, but that's not quite right. The outer 10% of a neutron star consists mostly of protons and even electrons, which can stably exist without being crushed at the surface. Because neutron stars rotate extremely rapidly -- more than 10% the speed of light -- those charged particles are always in motion, meaning

they produce electric currents and magnetic fields. The magnetic fields themselves should affect the particle/antiparticle pairs present in empty space differently, since they have opposite charges. And if you have light passing through that region of space, it should get polarized dependent on the strength of the field.



Direct laser pulse experiments seek to measure this vacuum birefringence under laboratory conditions, but have been unsuccessful so far. Image credit: Probing vacuum birefringence under a high-intensity laser field with gamma-ray polarimetry at the GeV scale, by Yoshihide Nakamiya, Kensuke Homma, Toseo Moritaka, and Keita Seto, via [https://arxiv.org/abs/1512.00636.](https://arxiv.org/abs/1512.00636)

This effect is known as vacuum birefringence, and occurs as the charged particles get yanked in opposite directions by the strong magnetic field lines. Because the effect scales as the square of the magnetic field strength, it makes sense to look at neutron stars for this effect. While Earth's magnetic field is about 100 micro Tesla, the strongest magnetic fields we produce on Earth are only about 100 Tesla: strong, but not strong enough. But with the extreme conditions of neutron stars, large regions of space contain magnetic fields in excess of 10^8 Tesla, making this an ideal place to look.

Although not very much light is emitted from the surface of the neutron star, the light that is emitted must pass through the strong magnetic field on its way to our telescopes, detectors and eyes. Because the space exhibits this vacuum birefringence effect, the light passing through it must get polarized, and it should all exhibit a common direction of polarization. By measuring the light from the very faint neutron star RX J1856.5-3754 with the Very Large Telescope in Chile, a team led by

Roberto Mignani was able to measure the polarization degree for the first time. The actual data shows a large effect: a polarization degree of around 15%.

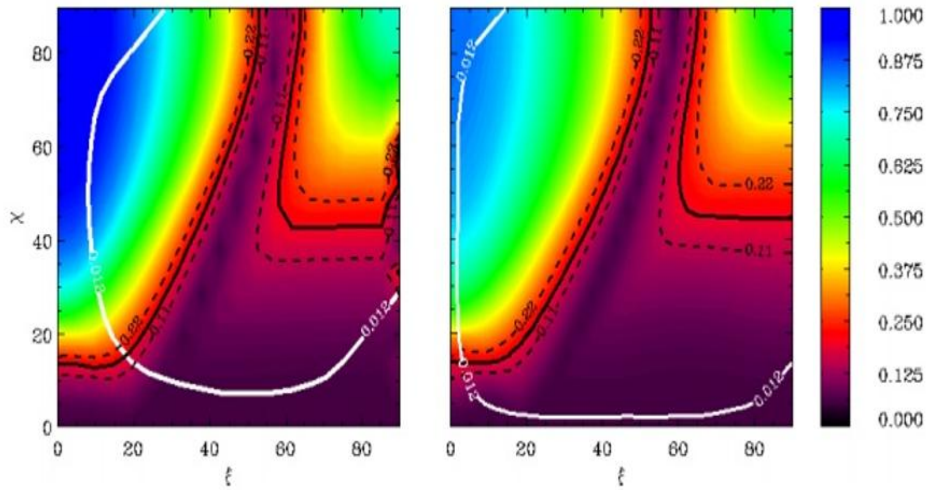


Figure 3. Contour plot of the phase-averaged linear polarisation degree in the VLT v_{HIGH} band for the isotropic blackbody (left) andthe gaseous atmosphere (right) models. The thick white line marks the locus in the $\xi-\chi$ plane where the computed pulsed fraction matches the observed value, 1.2% (Tiengo & Mereghetti 2007). The solid black line corresponds to the measured VLT optical polarisation of RX J1856.5−3754 while the dashed lines correspond to the $\pm 1\sigma$ error (P.D. = 16.43 ± 5.26%).

Measurement of the polarization around the neutron star RX J1856.5-3754. Image credit: Figure 3 from Evidence for vacuum birefringence from the first optical polarimetry measurement of the isolated neutron star RX J1856.5−3754, R.P. Mignani et al., MNRAS 465, 492 (2016).

The reason this neutron star -- as opposed to others -- is so perfect for this measurement is that most neutron stars have their surface obscured by a dense, plasma-filled magnetosphere. If we tried to look at the pulsar in the Crab Nebula, for example, we'd have no chance of making this observation at all. The region around it is simply opaque to the types of light we'd like to measure.

Heisenberg and Euler made this prediction all the way back in 1936, and it's gone completely untested until now. Thanks to this pulsar, we have confirmation that light polarized in the same direction as the magnetic field has its propagation affected by quantum physics, in exact agreement with the predictions from quantum electrodynamics. A theoretical prediction from 80 years ago adds another feather in the cap of Heisenberg, who can now posthumously add "astrophysicist" to his resume. But RX J1856.5-3754 can, in the future, confirm vacuum birefringence even more strongly by looking in the X-rays.

.We don't have a space telescope capable of measuring X-ray polarization today, but the ESA's upcoming Athena mission will do exactly that. As opposed to the ~15% polarization the visible light exhibits, X-rays ought to be ~100% polarized. Athena is currently slated for launch in 2028, and combined with giant ground-based observatories like the Giant Magellan Telescope and the ELT, should deliver this

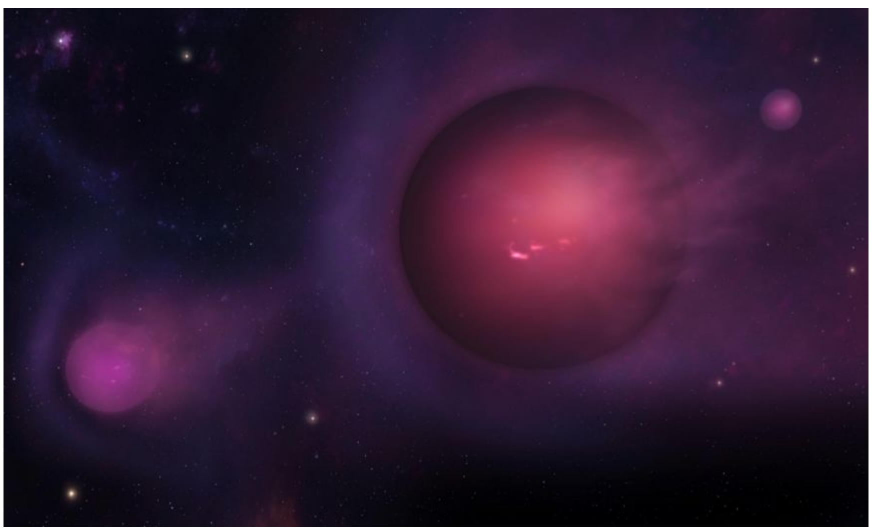
confirmation for many such neutron stars. It's another victory for the unintuitive but fascinating quantum Universe.

Reference: Evidence for vacuum birefringence from the first optical polarimetry measurement of the isolated neutron star RX J1856.5−3754, R. P. Mignani, V. Testa, D. Gonzalez Caniulef, R. Taverna, R. Turolla, S. Zane and K. Wu, MNRAS 465, 492 (2016).

Astrophysicist and author Ethan Siegel is the founder and primary writer of Starts With A Bang. Follow him on Twitter, Facebook, G+, Tumblr, and order his book: Beyond The Galaxy, today!

Is the Milky Way's black hole producing speeding 'spitballs'?

Astronomy: Credit Rod Verger



This artist's conception portrays a collection of planet-mass objects that have been flung out of the galactic center at speeds of 20 million miles per hour (Mark A. Garlick/Cf)

Apparently no one told the black hole at the center of our galaxy that it’s impolite to spit in public.

Theoretically, after a star is shredded in a tidal disruption event by the Milky Way’s supermassive black hole, the remnants of that star could form into a planet-sized gob that gets flung away at incredible speed, even out of our galaxy. These speeding objects are kind of like spitballs, according to the Harvard-Smithsonian Center for Astrophysics.

"A single shredded star can form hundreds of these planet-mass objects. We wondered: Where do they end up? How close do they come to us? We developed a computer code to answer those questions," Eden Girma, the lead researcher behind the work and an undergraduate at Harvard University, said in a statement.

The stellar leftovers could be traveling at incredible speeds: about as fast as 20 million miles per hour. And they don't stick around in our galaxy forever— an estimated 95 percent of them zoom out of the Milky Way. This new research has calculated the amount and destinations of these theoretical cosmic spitballs, according to James Guillochon of the Harvard-Smithsonian Center for Astrophysics.

"Some simulations by others have suggested that the debris from a star being disrupted by a black hole can clump up into planet-sized fragments, but those others did not calculate how many would be produced nor where they ended up," Guillochon said in an email to FoxNews.com. "I think the most exciting aspect is that there are expected to be about 100 million of them in the Milky Way, with the closest one being a few hundred light years away."

Galaxies like Andromeda could even be expelling these stellar spitballs, too.

"They will be very cold and very dark as they have no parent star heating them up," Guillochon added.

A star is sucked into the black hole and torn apart "every few thousand years," according to the Harvard-Smithsonian Center for Astrophysics, beginning the process that forms the fragments. NASA's James Webb Space Telescope, the space agency's next-gen replacement for Hubble, could theoretically detect them.

The first step in The research is being described in a forthcoming study, Guillochon said.

NASA DISCOVERY – 7 Earth like planets just 40 light years away.

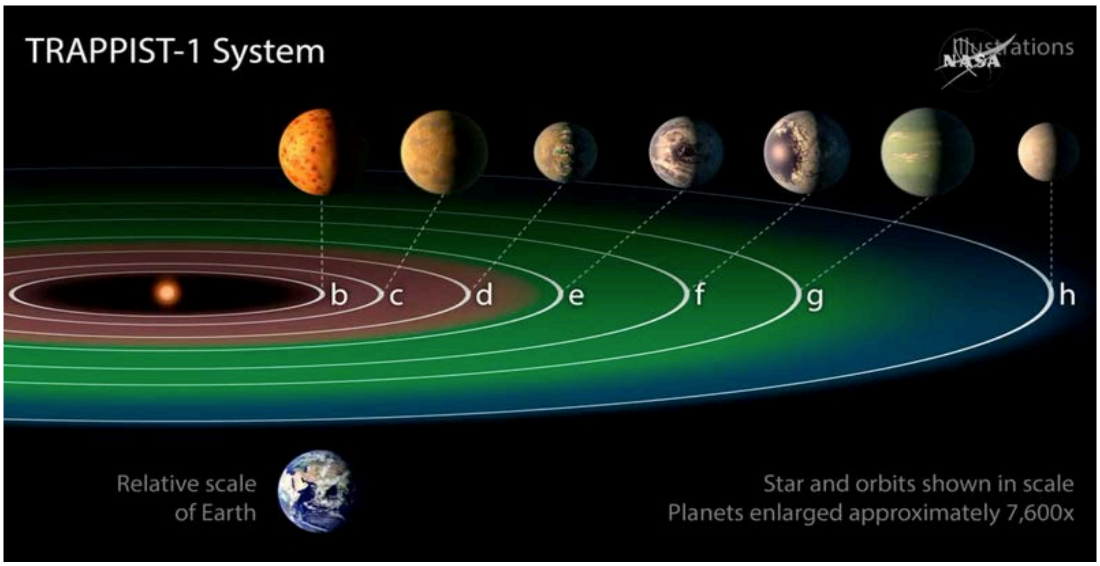
Finding life outside our own planet is to find a planet like our own: small, rocky, and at just the right distance from the star that liquid water could exist on its surface.

That's why an announcement today from NASA is so exciting: The space agency, along with partners around the world, has found seven potentially Earth-like planets orbiting a star 40 light-years away.

"It's the first time that so many planets of this kind are found around a same star," Michaël Gillon, the lead author of the *Nature* paper announcing the discovery, said

in a press conference. "The seven planets … could have some liquid water and maybe life on the surface."

Three of the planets are directly in the star's habitable zone, meaning water can mostly likely exist on the surface of them. One of them, Gillon said, has a mass "strongly to suggest a water-rich composition." And it's possible that the other four could have liquid water, too, depending on the composition of their atmospheres, the astronomers said.

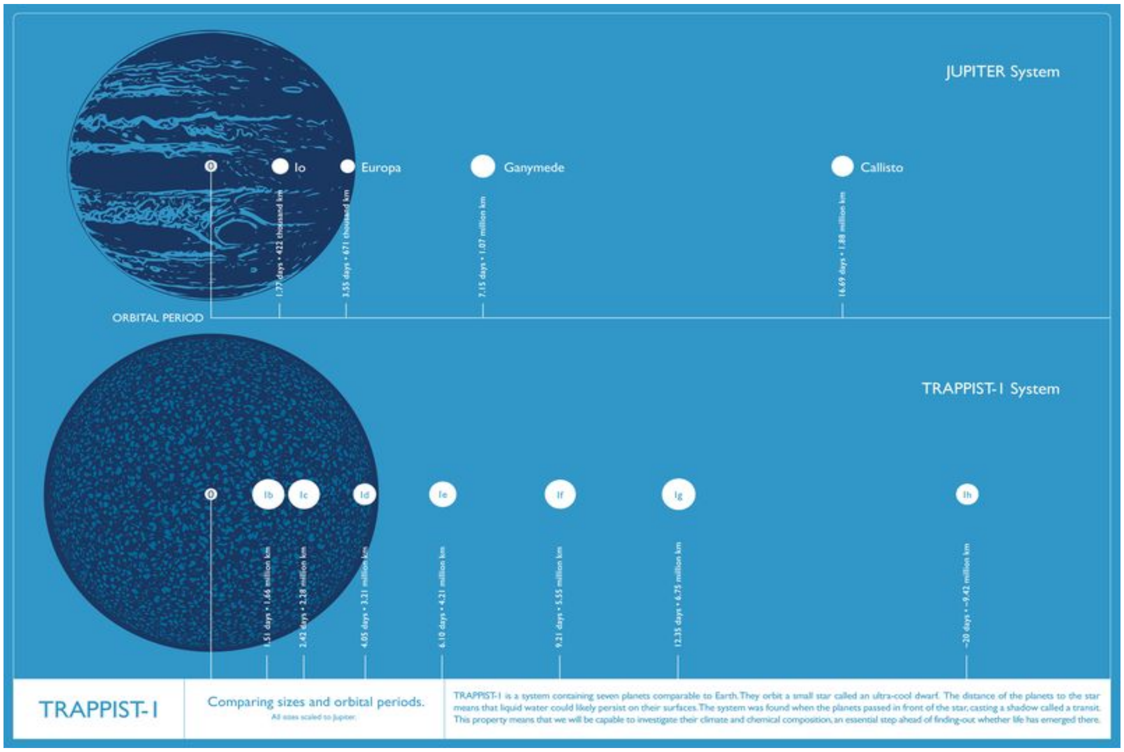


The planets "e," "f," and "g" — marked in green are directly in the "habitable zone" of this star system.

The exoplanets orbit a star in the constellation Aquarius called Trappist-1. And it's a solar system very different from our own.

For one, Trappist-1 is a tiny, "ultra-cool" dwarf star. It's cool because it's small: just about a tenth of the mass of our sun and about one-thousandth as bright. But its low mass allows its planets to orbit it very closely and remain in the habitable zone.

The distance at which the planets orbit Trappist-1 is comparable to the distance of Jupiter to its moons. All the planets are believed to be rocky, and are all believed to be around the size of Earth, give or take 10 to 20 percent.



The star's dimness is actually what led to the discoveries of these planets. When astronomers search for exoplanets, they typically look for a temporary dimming of a star — an indication that a planet has passed in front of it. This method makes it hard to find small, rocky worlds orbiting big, bright stars. If the planets are too small, they'll get washed out.

Planetary geology

Planetary geology, alternatively known as astrogeology or exogeology, is a planetary science discipline concerned with the geology of the celestial bodies such as the planets and their moons, asteroids, comets, and meteorites. Although the geo- prefix typically indicates topics of or relating to the Earth, planetary geology is named as such for historical and convenience reasons; applying geological science to other planetary bodies. Due to the types of investigations involved, it is also closely linked with Earth-based geology.

Planetary geology includes such topics as determining the internal structure of the terrestrial planets, and also looks at planetary volcanism and surface processes such as impact craters, fluvial and aeolian processes. The structures of the giant planets and their moons are also examined, as is the make-up of the minor bodies of the Solar System, such as asteroids, the Kuiper Belt, and comets.

History of planetary geology

Eugene Shoemaker is credited with bringing geologic principles to planetary mapping and creating the branch of planetary science in the early 1960s, the Astrogeology Research Program, within the United States Geological Survey. He made important contributions to the field and the study of impact craters, Selenography (study of the Moon), asteroids, and comets.

Today many institutions are concerned with the study and communication of planetary sciences and planetary geology. The Visitor Center at Barringer Meteor Crater near Winslow, Arizona includes a Museum of planetary geology. The Geological Society of America's Planetary Geology Division has been growing and thriving since May 1981 and has two mottos: "One planet just isn't enough!" and "“The GSA Division with the biggest field area!"

Major centers for planetary science research include the Lunar and Planetary Institute, the Applied Physics Laboratory, the Planetary Science Institute, the Jet Propulsion Laboratory, Southwest Research Institute, and Johnson Space Center. Additionally, several universities conduct extensive planetary science research, including Montana State University, Brown University, the University of Arizona, Caltech, the University of Colorado, Western Michigan University, MIT, and Washington University in St. Louis.

As I began to study this topic, I was quite amazed by the amount of information I found available on the net. If you are interested in learning more, Google Geological features of the solar system.

STAR PARTIES PRESENTED BY THE DELAWARE ASTRONIMICAL SOCIETY

April 3, 2017 7:30 pm - 9:00 pm
Introduction to the Night Sky at Bellevue State Park

DAS & MCAO present an introduction to observing the night sky for all ages. Equipment will be available or bring your own. Red-filtered lights only, please. Meet at the Hunter Barn parking lot. No fee. Click here for more information.

April 7, 2017 6:30 pm - 8:00 pm
Outreach at Woodside Farm Creamery

May 5, 2017 7:00 pm - 8:00 pm
Outreach at Woodside Farm Creamery

June 9, 2017 7:30 pm - 9:00 pm
Outreach at Woodside Farm Creamery