"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

JUNE 2019

Monthly meeting This month's meeting will take place on **Monday 24 June** at the **Catholic Church Hall** starting at **19.00.** The later date was selected because the Monday of the third week in June is a public holiday. Dr Moses Mogotsi from the SAAO in Cape Town will be talking on 'Star formation and the gas cycle in galaxies'. See below for details.

Stargazing No event is planned for June.

WHAT'S UP?

Saturn in Sagittarius Saturn is in Sagittarius for the whole year, and is visible throughout the night during June and until September. The slightly elongated shape visible through binoculars is resolved into the planet and its rings with a small telescope. Like Jupiter, Saturn has surface bands, but these are much fainter than they are on Jupiter. Observing Saturn with binoculars provides an excellent opportunity to also find some of the numerous open and globular clusters located within the boundaries of Sagittarius. The 15th largest constellation offers so many riches because it is the are of sky which lines up with the galactic centre. Therefore, there ia great density of celestial objects is present as an observer looks through the depth of the galactic disk. Some clusters can be found within the area of the distinctive 'teapot' shape found at the centre of the constellation, but the skies arching over the 'lid' contain even more objects easily found through binoculars.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The presenter at the 20 May meeting was Dr Daniel Cunnama, Science Engagement Officer at SAAO. Daniel gave a very interesting talk on 'Simulations of galaxies and galaxy clusters'. Firstly, he showed that stars in galaxies are not randomly arranged, and that the same is true for galaxies themselves. Galaxies are grouped in clusters, which, themselves, are linked to one another. This universal structured network is called the cosmic web. Then he explained that only 20% of the matter in galaxies is visible. The other 80% is dark matter. It is invisible, but several sources of evidence show that it is present, and directly affecting the nature of galaxies. Together, matter and dark matter form only 24% of the universe. Dark energy is the third component, the energy which is causing the universe to expand.

Referring to the structure of the cosmic microwave background, whose tiny variations in temperature are evidence of how the early universe began evolving into the structured cosmos observed today, Daniel then showed how useful computer simulations and modelling are proving to be in explaining how the universe evolved. Running these has shed light on both what the early universe looked like and how and why the cosmic web was formed. They have shown that it is dark matter which is the scaffolding on which stars and galaxies rest. It forms the filaments of the web, and stars and galaxies form where these intersect, resulting in the galaxy clusters observed today.

Interest groups

Cosmology At the meeting on 6 May, Pierre Hugo presented the ninth part in the current series on 'Natural philosophy: science for non-scientists'. The topic was Gravity – spatial flow'.

Astro-photography At the 13 May meeting, attendees continued working on processing their own astro-images.

Other activities

Educational outreach

Hawston Secondary School Space Cadets Weekly meetings stopped after early May as learners had exams.

Lukhanyo Youth Club Work continues on the construction of analemmatic sundials here and other schools in the Overstrand.

Science workshop On 20 May, Dr Daniel Cunnama, Science Engagement Officer at SAAO led a workshop at SANSA for science teachers and learners from 7 Overstrand schools. Assisted by Pierre de Villiers, his topic was 'Seasons', which forms part of the school curriculum.

Stargazing Unfortunately, adverse weather conditions meant that the events scheduled for 3 or 4 May both had to be cancelled. In addition, a planned alternative, viewing the lunar occultation of Saturn on 22 May, also had to be cancelled due to cloudy skies.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on **Monday 24 June** at the **Catholic Hall** starting **19.00**. The presenter is Dr Moses Mogotsi from SAAO in Cape Town. His presentation will be on 'Star formation and the gas cycle in galaxies'. Moses obtained his PhD at UCT in 2016. The title of his thesis was 'The star formation and dynamics of nearby galaxies'.

The Cape Centre stated the following before he gave this talk in Cape Town in 2018. "Star formation is an important process in how galaxies change with time and also for how we end up with a planet such as ours orbiting the Sun. Stars require cold gas to form and after they form and eventually die, they interact with surrounding gas. This is called feedback and can result in strong outflows which blow out material from galaxies, resulting in possible new star formation.

There is ongoing research about how galaxies accumulate cold gas to form stars and how feedback from star formation affects this gas and star formation. Dr. Mogotsi is involved in multiple projects studying star formation, feedback and gas flows in nearby galaxies. He will talk about this research and how the world's leading telescopes such as, the Hubble Space Telescope, Very Large Telescope (VLT), Southern African Large Telescope (SALT),

Very Large Array (VLA), Atacama Large Millimeter Array (ALMA) and MeerKAT are being used to explore the cycle of gas in galaxies and how it relates to star formation.'

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting is on **Monday 3 June** at the **Catholic Hall**, starting at **19.00.** Pierre Hugo will lead the tenth session in the series 'Natural philosophy: science for the non-scientist'. The topic will be 'Space warp'.

There is an entrance fee of R10 per person for members, R25 per person for non-members, and R10 for children, students and U3A members. For further information on these meetings, or any of the group's activities, please contact Pierre Hugo at pierre@hermanus.co.za

Astro-photography This group meets on the second Monday of each month. The next meeting will be on **Monday 10 June.**

To find out more about the group's activities and the venue for particular meetings, please contact Deon Krige at astronomy.hermanus@gmail.com

Hermanus Youth Robotic Telescope Interest Group Developmental work on this will resume soon.

For further information, please contact Deon Krige at deonk@telkomsa.net

Other activities

Stargazing No events have been planned for June.

FUTURE TRIPS

Planning is underway for an outing later this year. Members will be sent details once the arrangements have been made.

2018 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the **Catholic Church Hall**, beginning at **19.00**.

24 June	'Star formation and the gas cycle in galaxies'. Presenter: Dr Moses Mogotsi, SAAO., CT
15 July	'Near-Earth asteroids: monitoring close approaches and mitigating objects'. Presenter: Dr Nicolaus Ersamus, SAAO, CT
19 August	'More unusual curvaceous geographical wonders of Earth'. Presenter: Jenny Morris, Centre member
16 September	Topic TBA. Presenter: Pierre de Villiers, Centre chairman
21 October	'The upgraded HESS facility in Namibia'. Presenter, Herbert Pioller, Centre member
18 November	'The Cassini family dynasty and their Saturnian legacy'. Presenter: Jenny Morris, centre member
9 December	Xmas party

ASTRONOMY SELF-GUIDED EDUCATION CENTRE (ASEC)

Work continues on planning and administrative requirements for work to begin on the proposed Astronomy Self-guided Education Centre, to be located within the existing whale-watching area at Gearing's Point.

The **Friends of the Observatory campaign** was launched several years ago when preliminary work began on plans to construct an astronomical observatory in Hermanus. Over the years, members have been very generous, for which we are deeply grateful. It may seem logical to assume that, now money has been awarded by the National Lotteries Board, pledge monies are no longer needed. Unfortunately, that is not the case. NLC funds can only be used once the plans have been formally approved by the Municipality.

We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer, The Standard Bank details are as follows:

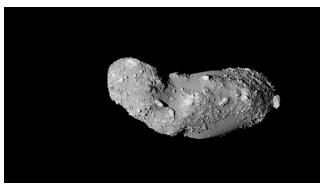
Account name – Hermanus Astronomy Centre
Account number – 185 562 531
Branch code – 051001

If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

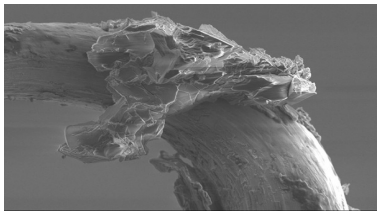
ASTRONOMY NEWS\

Asteroids delivered half of Earth's water, new sample suggests 1 May: In 2010, a Japanese mission called Hayabusa returned to Earth from a seven-year space journey. It brought back not only images and data from its adventure, but also actual samples, small grains of rock from its target, the asteroid Itokawa. Just a handful of space missions have ever returned to Earth at all, let alone brought back pieces of their destinations. So Hayabusa's samples are highly prized, and have been studied by many teams across the world.

Researchers from Arizona State University have analysed a tiny subset of Hayabusa's collection, and uncovered a surprising amount of water contained within the rock grains. The finding puts stony asteroids like Itokawa back in the spotlight, reigniting a long-standing debate among scientists over where Earth's vast oceans come from. Did the water originate from comets, asteroids, or some other source altogether?


The Japanese Space Agency, JAXA, reached asteroid Itokawa in 2005 and returned a sample to Earth in 2010. JAXA

Researchers Ziliang Jin and Maitrayee Bose got just five grains from Hayabusa, each spanning a mere half the width of a human hair. Two of those five particles contained the mineral pyroxene, which on Earth often contains water. The pair used an instrument called a mass spectrometer to see how much water there was in Itokawa's pyroxene. What they found surprised them. Not only were Itokawa's grains rich in water, but the chemistry of that water very closely matches the water on Earth.


Dust grain from asteroid Itokawa studied in an earlier analysis. ESA

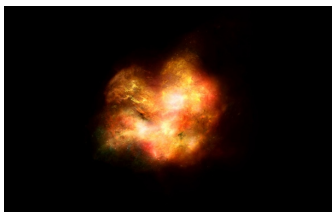
For decades, scientists have wondered where Earth got all its water. Did Earth form with its water baked in, or was it delivered later by a cosmic hailstorm of comets or asteroids? If so, which? The evidence has tipped back and forth over the years. Much of the uncertainty is because scientists have very few physical samples to study.

Not all water is created equal. Most water contains one atom of oxygen and two atoms of hydrogen: H2O, but some contains deuterium instead of conventional hydrogen. It is a heavier version of hydrogen that has an extra neutron at the centre. When scientists find the source of Earth's water, they expect it will match the fraction of deuterium that scientists observe in Earth's oceans today. Measuring that is tricky to do without physical samples like those from Itokawa.

Itokawa is just one asteroid. However, it comes from a population of space rocks that orbit between one-third and three times Earth's orbit, meaning they are local. There are many asteroids like Itokawa that could have impacted Earth long ago. Of course, the samples that Hayabusa plucked from Itokawa's surface in 2005 have been through a lot in the aeons since Earth gained its water. So Jin and Bose had to run the clock backward, accounting for the heating, weathering, and collisions that Itokawa would have endured since the early days of the solar system. What they found is that Itokawa and rocks like it could have delivered half of Earth's water reservoirs. Since they come from the same region of the solar system as Earth itself, the researchers conclude that our planet could have nabbed the rest of its water as it was forming, from the materials around it.

The argument over Earth's watery origins will likely continue. Hayabusa's successor, Hyabusa2, is currently in orbit around another asteroid, Ryugu, and a NASA mission called OSIRIS-REx is exploring Bennu. Both missions will bring home their own asteroid samples and add to growing evidence about the origin of Earth's oceans. By: Korey Haynes

Early galaxies shone brighter and hotter than expected 10 May: Our universe's first galaxies shone hotter and brighter than scientists thought, according to a group of astronomers who tapped a substantial 400 hours of observing time on NASA's Spitzer Space Telescope. The discovery could answer a long-standing question about how light first travelled freely through the infant universe.


The first galaxies shone bright and hot, lighting up the cosmos around them. James Josephides

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

After the Big Bang, our universe was mostly gas. It took some 100 to 200 million years for the first stars to form. It took another billion years or so for those suns to come together as the first galaxies. For most of this period, the universe was packed with cold hydrogen

gas. Some kinds of light can pass through such gas uninhibited, but higher-energy radiation, like ultraviolet light and gamma-rays, gets absorbed immediately. That stops this light from streaming freely across space where one day, billions of years in the future, it might strike an Earth observer's telescope.

As these first stars and galaxies started filling our early universe with high-energy radiation, all that gas was saturated with light until it just could not absorb any more, and light began racing freely across the cosmos. This transition is known as the epoch of reionisation, and it marks the cloudy edge of cosmic history, past which astronomers will never see. Researchers understand this barrier and its cause in general terms. However, exactly when this ionization happened, and how, has remained a puzzle. Astronomers still debate the specific sources of all that radiation.

That is why these new observations are important. Spitzer's deep look let astronomers see specific wavelengths of light from the universe's earliest galaxies. The results show that the first galaxies were extremely light in 'metals',s which is what astronomers call any elements beyond hydrogen and helium. The discovery also implies that the stars within those galaxies then held few heavy elements, which helped them burn hot and churn out the kind of ionizing radiation that would clear the gas' veil from our cosmos.

These hot stars formed the early galaxies that Spitzer studied, making them brighter than today's galaxies, and brighter than astronomers had expected. While some examples of such surprisingly bright galaxies have been spied before in previous searches, the Spitzer survey (called GREATS, and based on a Hubble survey called GOODS) included 135 early galaxies. This tells astronomers that such brightness was common in these early galaxies, and not a trait belonging to a few spectacular outliers.

It is still not clear if these bright galaxies could ionise the universe all on their own, or if extra sources of light - like the radiation that roils off actively feeding black holes at the centre of galaxies - may also be responsible. Telescopes like James Webb, due to launch in 2021, will be more than seven times larger than Spitzer, and able to study the universe's early days in even greater detail. Perhaps one day, astronomers will have a true answer as to what objects were responsible for turning on the lights in the cosmos.

By: Korey Haynes

Project Artemis: NASA names its 2024 Moon mission 14 May: On Monday night, NASA Administrator Jim Bridenstine announced the space agency has named its planned mission to put humans back on the lunar surface: Artemis. As the Greek deity most associated with the Moon, and the god Apollo's twin sister, the namesake choice was an obvious fit.

A lander touches down on the Moon's surface in this screengrab from a new NASA promotional video about its plans for 2024. NASA

On the logistical side, Bridenstine also announced that NASA will ask Congress for an additional $1.6 billion in funding to jumpstart the program. NASA has not put forward a

full budget for the ambitious Artemis program, which the Trump administration says will put humans on the Moon again by 2024. Bridenstine said previous reporting, which rumoured that Artemis would cost $8 billion annually on top of NASA's normal budget, was incorrect. He declined to offer a number of his own, however. President Donald Trump also mentioned the lunar plans for the first time last night, tweeting about the $1.6 billion budget increase.

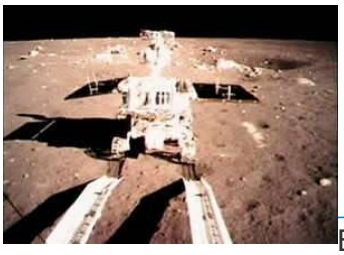
This funding would have to be approved by Congress, and it is unclear whether there is broad support there for such increases. While the exact funding sources were not mentioned during the telecon, the overall budget requested by the White House has not increased. Bridenstine did specify that the money is not coming at the expense of other NASA projects.


After nearly 50 years away, NASA hopes to land humans on the Moon in the next five years. NASA

Money is not the only challenge to the lunar program. SpaceX and especially Boeing, who contract to build craft and fly missions for NASA, are both facing technological difficulties with their crew-carrying spacecraft just to get humans to the International Space Station. And the space agency itself has seen delays to its Orion capsule, which NASA designed with the intention of sending astronauts into deep space. Adding to the challenge, NASA does not currently have a craft on hand that can land cargo, let alone humans, on the Moon, and the timelines for developing such missions have continued to slip. Last week, Amazon found Jeff Bezos announced that this spaceflight company, Blue Origin, is bulding a lunary lander that could help NASA out.

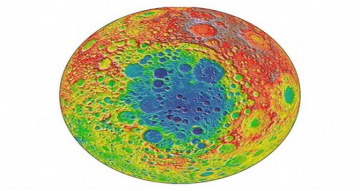
Furthermore, NASA does not currently have spacesuits suitable for lunar exploration, and none of the $1.6 billion is earmarked for suit research and development. The challenges are steep given the tight time constraints to land humans – and particularly a woman, as Bridenstine has claimed as an additional goal – on the Moon's surface by 2024, the end of Trump's potential second term. Whether they can be accomplished depends in large part on whether the funding requested is adequate to meet those goals, and whether it gets approved at all. If it does happen, Artemis will take her place alongside Apollo in the grand history of human space exploration. Unlike Apollo, perhaps Artemis will let humans make a more permanent stand on the Moon. By: Korey Haynes

China's Yutu-2 rover finds ancient rocks in Moon's biggest crater 15 May: Since January, China's Chang'e-4 mission – an orbiter and a rover – has been exploring the far side of the Moon, particularly the prized South Pole-Aitken Basin, an asteroid impact crater that stretches across nearly a quarter of the Moon's surface. It is the biggest crater on the Moon, as well as the deepest and the oldest. That has long left scientists suspecting that Aitken may hold vital clues as to how the Moon – and many other solar system bodies – evolved.


The Yutu-2 rover has been exploring the Moon's South Pole-Aitken Basin. CNSA

Now, the Chang'e-4 mission's Yutu-2 rover, which is still driving across Aitken Basin, has finally discovered Moon dirt that researchers think originated deep underground in the Moon's mantle, underneath the lighter surface material. Meteor impacts into Aitken Basin's already-thin crust might have excavated this material, which is markedly different from the surface rocks and regolith most lunar missions have studied. By examining those minerals, scientists say they now have a better idea of how our Moon formed and evolved.

The Moon formed early in our solar system's history when Earth smashed into a Mars-sized planet called Theia. Like many large solar system bodies, researchers think that when the Moon was very young, it was covered with a magma ocean. As the Moon cooled, the heavier materials sank toward the lunar core, while the lighter material floated to the top, where they were preserved as the lunar surface we see today. In between these is a medium layer called the mantle. Unlike the Earth, with its volcanoes and plate tectonics and deep ocean rifts, the Moon has not reshuffled its layers very much. So, the only way to bring the heavier materials to the surface is likely through meteor impacts that hit hard enough to break through the surface layers to the deeper mantle underneath – especially millions or billions of years ago when that lower layer was still molten.


This view of the South Pole-Aitken Basin highlights just how large and deep the crater is. Blue represents an elevation of about 8 km below the average level of the lunar surface, while red represents an elevation of about 6.5 km above the surface.

The most likely place for this to have happened is the Aitken Basin, where one huge impact carved out an extremely large and deep crater, and almost certainly cracked into the lunar mantle. This should have flooded the area with denser minerals like olivine and pyroxene. The Yutu-2 rover used a spectrometer instrument to explore flat areas in the bottom of this crater, but found only a few traces of those minerals. However, when it explored craters within the crater – where later meteors struck the already-thin surface – the rover found more of the materials it was searching for.

This is strong support for the idea of deeper impacts excavating mantle material that is made up of different kinds of minerals from the more familiar surface rocks and dirt. It is a good confirmation for what many scientists had already suspected about what the interior of the Moon really looks like, and that it evolved in the layered way that researchers thought. Yutu-2 will keep exploring. While the stories the craters tell is illuminating, the researchers need to be sure that the material truly came from inside the Moon – this means looking carefully at how the material has been moved around by the years and later meteor strikes. While Yutu-2's instruments are good, they are not as good as a hands-on laboratory. The best, most convincing evidence will come from bringing samples

back from the Moon's deep impact sites to study them on Earth – something NASA is keen to try in the coming years. By: Korey Haynes

New Horizons reveals Ultima Thule's quiet, lonesome past 17 May: After New Horizons streaked past Pluto in 2015, its main task was over, but it still had work to do. On New Year's Day of 2019, it made a flyby of another, even more distant object named 2014 MU69, more commonly called Ultima Thule. Since then, the spacecraft has been slowly but steadily sending streams of information back across the increasingly vast gulf of space between it and Earth.

New Horizons visited Ultima Thule on New Year's Day, NASA/JHU-APL/ SwRI//Roman Tkachenko

From that information, scientists now know that the snowman-shaped space rock formed from a gentle collision of two bodies, that astronomers now refer to as Ultima and Thule. In general, Ultima Thule seems to have had a calm history, with little variation across its surface, leading astronomers to rule out more violent collisions that would lead to a more patchwork appearance. These and other details were revealed in a study led by Alan Stern of the Southwest Research Institute.

Ultima Thule's calm history falls neatly into place with other recent observations. There are a whole herd of spacecraft taking data on oddball space rocks, and where those rocks orbit seems to tell astronomers a great deal about what to expect from their histories. For objects in the asteroid belt and elsewhere in the middle of the solar system, it is common to see a history of violence. Due to their closer tracks to the Sun, these objects move faster, and collide more violently. Objects often break apart into smaller pieces on collision, instead of merging together, and many of the objects currently under investigation show signs of once being part of larger bodies. They are also more active right now, when more direct exposure to sunlight can cause surprising activity on their surfaces.

However, for objects in the Kuiper Belt around Pluto and beyond, astronomers see evidence of a more peaceful existence. Because these objects orbit so far from the Sun, their orbital speeds are slower (this is a basic tenant of Kepler's laws). Also, the solar system is generally less crowded as you look farther out from the Sun. So, objects collide less often, and at slower speeds, resulting in less small debris. Pluto showed this phenomenon in its relative lack of impact scars. Ultima Thule backs up the same ideas.

While the first images New Horizons sent back showed apparently distinct regions on Ultima Thule, more detailed investigations show little variance in colour or composition, again pointing to a history lacking sharp or recent changes. New Horizons also found no signs of dust, moons, or rings around Ultima Thule, another sign that it has spent much of its history alone and undisturbed. Ultima Thule did offer one big surprise. Rather than a fully round snowman, the two pieces of the asteroid appear to be flattened, more like two pancakes that were poured too closely in the pan and grew together. Since most space rocks are at least vaguely spherical, the flattened nature of Ultima Thule perplexes

astronomers. So far, it is not clear what caused the flattening.

Astronomers often look to asteroids as the building blocks of the solar system, since they have undergone far fewer changes than the material that was long ago incorporated into large, complex bodies like planets and their often active moons. The rest of the New Horizons data will not finish downloading to Earth until next year, when astronomers can finish mining Ultima Thule's secrets. By: Korey Haynes

Thin, insulating layer may prevent Pluto's underground ocean from freezing 20 May: Pluto has left astronomers puzzled ever since the world was discovered in 1930. Its mysteries only grew in the aftermath of NASA's New Horizons probe, which cruised by the dwarf planet in 2015. One point of confusion is Sputnik Planitia, part of the now-familiar heart-shaped region on Pluto's northern hemisphere.

Pluto's Sputnik Planitia may be insulating its underground ocean. NASA/JHU-APL/SwRI

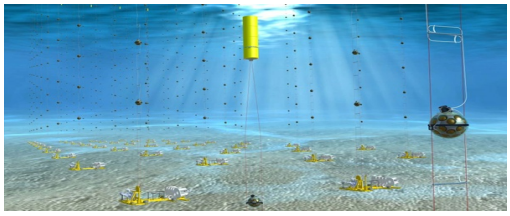
New Horizons' instruments hinted that there might be an underground ocean in the region. Otherwise, the tiny, far-off world would be so cold it would have frozen through entirely. Yet Pluto's crust in the same region is thinner in some areas than others, and that only makes sense if it is frozen hard – warmer slush would spread out more evenly. Astronomers have been trying to explain those apparent contradictions ever since.

A team of Japanese researchers led by Shunichi Kamata thinks they have an answer. They say that a thin layer of insulation – gases like methane trapped inside an ice layer – may be the key to keeping Pluto both very cold and not quite frozen. The scientists suspect this insulating layer is made of a material called clathrate hydrates, which are gases trapped in a solid layer like ice. On Earth, we think of freezing oceans producing more or less normal water ice. However, on Pluto, the oceans may have large amounts of dissolved gases and other substances. If the oceans produce a frozen top layer, it would include these gases, trapped inside the ice – and that substance would not act the same as normal ice.

Instead, this layer would have some unique properties that fit into the strange puzzle of Pluto's ocean and ice layers. The layer is a good insulator – it does not exchange much heat with the materials around it. Also, it is viscous, supporting the slow movement of ice that leads to the strange differences in thickness scientists observed at Sputnik Planitia. There are a few options for what kind of gas could be hidden inside this insulating layer. One of the more likely suspects is methane, since Pluto and many bodies like it have plenty to spare.

Kamata and her colleagues came to their conclusions by using detailed modelling, and matching what their computer simulations predicted to what New Horizons has already revealed about Pluto. Pluto is not the only cold world suspected to have underground oceans. So while New Horizons is long past Pluto now, scientists could still look for chances to observe this insulating layer in more detail. By: Korey Haynes

Why scientists are putting a telescope on the bottom of the ocean 23 May: Deep under the Mediterranean Sea, hundreds of watchful eyes hang suspended on cables, waiting for a rare and valuable flash. Their quarry is ghostly neutrino particles, capable of tunnelling through light-years of space and a planet's worth of rock without ever coming into contact with matter. Here, under the ocean, they just may hit a detector from the Cubic Kilometre Neutrino Telescope, or KM3NeT. While the international collaboration is still in the early stages of construction, it hopes to soon begin tracking some of the most elusive particles in the universe.


The Cubic Kilometre Neutrino Telescope, once complete, will be made of hundreds of spherical detectors suspended at the bottom of the sea. KM3NeT

Neutrinos are nearly massless particles produced in the sun and in energetic events like supernovas, colliding stars, and gamma-ray bursts. Because the particles barely interact with the rest of the universe, they are notoriously difficult to study, though trillions pass through your body every second. Researchers have tended to bury neutrino detectors in vats of supercooled liquids or miles underground, hoping that neutrinos will be the only particles that make it through. This time, they are hiding the detectors at the bottom of the sea, on the other side of the planet from the skies they hope to study, to block everything but neutrinos from hitting their detectors.

Most neutrino detectors look for the rare flashes of energy the particles give off when they collide with the nuclei of atoms. However, because these interactions do not happen very often, neutrino detectors have to cover a lot of ground – quite literally. KM3Net, as its name implies, will one day occupy a cubic kilometre of seawater – about 400,000 Olympic swimming pools worth. Neutrino detectors also have to be protected from the onslaught of regular radiation, which would otherwise drown out the fainter gleam of neutrino interactions. So. researchers build them deep underground, in abandoned mines or underneath Antarctic ice sheets.

Now, they are trying one at the bottom of the sea – and the other side of the world. "The underwater telescope is bombarded by millions of different particles but only neutrinos can pass through the Earth to reach the detector from below," said Clancy James, a researcher at the Curtin Institute of Radio Astronomy in Australia, a KM3Net partner. "So, unlike normal telescopes, it looks down through the Earth at the same sky viewed by upward-facing telescopes in Australia."

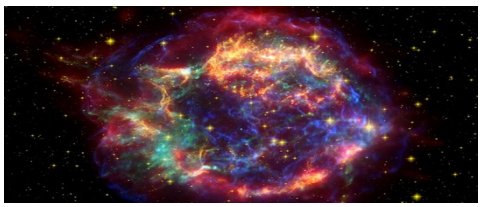
Each telescope is actually made up of hundreds of spherical detectors a little bigger than a basketball. These are suspended on vertical lines, and each node is connected by cables that run along the sea floor. The first test components were installed in 2013, with another round of construction in 2015 and 2018. Scientists are currently testing a limited number of detectors, and they are still searching for funding to make the full array a reality. Two telescopes comprise KM3Net. One is called ARCA, or Astroparticle Research with Cosmics in the Abyss, and it sits off the coast of Italy. It will study the higher-energy cosmic neutrinos produced by the universe's most energetic events, like gamma-ray

bursts, and provide scientists with a greater understanding of powerful astrophysical events. Its partner is ORCA, or Oscillation Research with Cosmics in the Abyss, located closer to France. This telescope will study the lower-energy particles produced by cosmic rays striking Earth's atmosphere.

So far, the telescope's operations have been for testing purposes, proving that the setup is successful using only a few of the eventual hundreds of detectors. The team is in the process of adding more. The completion of the telescopes will mean that astronomers do not have to get very, very lucky to spot a neutrino signal. Instead, the large array should open new windows into the hard-to-view world of barely-there particles.

By: Korey Haynes

Could a supernova have made humans bipedal? 28 May: In one fiery burst, an exploding nearby star millions of years ago might have helped change the course of life on Earth. Upon its death, this supernova sent high-energy charged particles, called cosmic rays, racing across the universe. A new study says those cosmic rays might have led to an uptick in wildfires across the globe by sparking lightning bolts. Those wildfires might, in turn, have altered our planet's ecology at a key moment in humanity's evolutionary history.



Composite image of the supernova Cassiopeia A. NASA

The new research attempts to tie together cosmic and terrestrial conflagrations to explain a curious uptick in wildfires 7 to 8 million years ago on Earth. By looking at another supernova 2 to 3 million years ago, the researchers say that they have found a mechanism by which supernovas could kick off earthly blazes. There is some evidence for a supernova 6 to 10 million years ago, which would help explain the wildfire boom then. Those fires turned vast forests into the sprawling grasslands we see in Africa today, something that has been previously argued to have helped convince humans to become bipedal.

Based on samples of iron-60 - a radioactive form of iron created in supernovas - taken from the ocean floor, scientists believe one occurred nearby around 2 to 3 million years ago. The study looked into what might have happened after this event, and uses that data to suggest that it or similar supernovas may have led to human ancestors becoming bipedal. "Right now we have quite strong evidence for a supernova 2 to 3 million years ago," said Brian Fields, an astronomer at the University of Illinois Urbana-Champaign who was not involved with the new research. "Once you see that data you're obliged to ask, what are all the effects that such a supernova could have?"

A nearby supernova would have definite consequences for our planet. In addition to shining brightly in our skies for a time, an exploding star nearby would shower Earth with elements like iron, silicon and oxygen as well as high-energy radiation in the form of ultraviolet, X-rays and gamma rays. Cosmic rays, which are actually composed of atomic nuclei and protons, would bombard Earth as well. When the cosmic rays reach Earth, they ionise and break down particles in the atmosphere. This process has been previously been found to increase the number of muons, a damaging elementary particle that can mutate

DNA. However, the researchers looked at another consequence of these cosmic ray showers.

In addition to more muons, the cosmic rays would also create a cascade of free electrons, they say, which have previously been shown to initiate lightning. "The atmosphere down in the bottom mile near the Earth is affected [by the cosmic rays]," said Adrian Melott, professor emeritus at the University of Kansas, lead author. "That makes it more electrically conductive, so it's easier for a lightning bolt to get started."

Although today humans start most wildfires, natural wildfires are almost entirely caused by lightning. An increase in lightning strikes would likely lead to more wildfires worldwide. The evidence for increased wildfires 2 to 3 million years ago, when scientists are confident a supernova occurred, is still slim. However, there may have been an earlier supernova that occurred around the time of an unexplained global wildfire boom. Samples of carbon and other chemicals in the geological record show an increase in wildfires beginning 6 to 10 million years ago, which likely contributed to an ecological shift from flammable forests to fire-hardy savannah around the world. In this new environment, some scientists have argued, standing on two legs would confer the ability to better see predators and prey over the tall grasses. The exact cause and timing of human bipedalism is still under debate, though there is some evidence to suggest it may have begun around 7 million years ago.

The new study suggest that this wildfire increase, which has previously gone unexplained, may be due to a nearby supernovae 7 to 8 million years ago. Evidence for a supernova then, however, is still preliminary, though Fields said it may emerge in the future. "With iron-60 you can't go back much further than [7 or 8 million years] because it all decays away," Fields said. "But looking for more exotic stuff like plutonium, there have been hints that, if [they] can be confirmed, would reach much further back in the past."

By: Mara Johnson-Groh

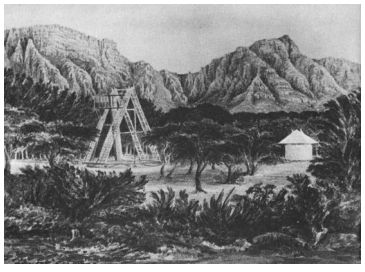
Source of these and further astronomy news items: www.astronomy.com/news

DID YOU KNOW

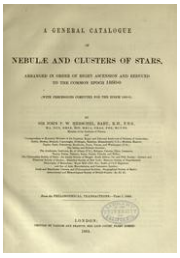
Astronomical catalogues Part 8: The Herschel's catalogues – first to record deep sky objects for the whole sky

William Herschel

John Herschel



John Herschel's telescope



The General Catalogue

A father and son were next to build on the work done by John Flamsteed. William Herschel (1738 – 1822), a German-born musician, moved to England in 1757. From 1773, with his sister Caroline, he focused almost all his time on his great interest in astronomy.

Observing with a series of ever-larger self-built telescopes, he discovered. amongst other objects, the planet Uranus and several of the moons orbiting the gas giants.

In 1781, he obtained a copy of the updated Messier catalogue. This sparked a desire to survey the northern sky for other deep sky objects. By the end of the century, he had observed and his assistant, Caroline, had catalogued many double stars and other 2,000 nebulae and clusters. The first edition of their *Catalogue of Nebulae and Clusters of Stars (CN),* containing 1,000 entries, was published in 1786. It was a development of Flamsteed's *Historica Coelestis Britannica (British Catalogue).* Another 1,000 entries were added to the 1789 edition and a further 500 to the 1802 third edition. The entries in William Herschel's catalogue identified each objects with the letter H followed by its position in the catalogue.

John Herschel (1792 – 1871) followed in his father's steps as an astronomer, continuing observations of double stars and nebulae. His survey of objects in the southern hemisphere was particularly important. It was designed to complete and extend the survey William had undertaken of the northern sky. During his stay in the Cape, from 1834 to 1838, John made observations with his private 6.4m long telescope. He identified over 2,100 double stars and more than 1,700 nebulae and clusters.

Back in England, he combined his observations with his father's northern hemisphere discoveries in the *General Catalogue of Nebulae and Clusters of Stars (GC)*, which was published in 1864. It contained 5,079 entries, covering the whole sky. After his death, a complementary catalogue was published of other Herschel observations, titled the *General Catalogue of 10,300 Multiple and Double Stars.* In it, the lower case prefix 'h', followed by the catalogue number, was used as each entry identifier.

The Herschel's CN and GC catalogues became the foundations for the system used today for the identification of deep sky objects. The person responsible for these developments was the astronomer John Dreyer. Based in Ireland, he published a supplement to the *General Catalogue* in 1878, adding about 1,000 new objects. He proposed a second supplement in 1886. However, the Royal Astronomical Society asked him to compile a new version instead. This new version introduced the NGC and IC numbers still in use today.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.en.wikipedia.org

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