"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

AUGUST 2018

Monthly meeting This month's meeting will place on **Monday 20 August** at the **Catholic Church Hall** starting at **19.00**. In a change to the schedule, Centre member, John Saunders, will be talking on 'Our weird and wonderful universe'. See below for more details.

Cosmology interest group A new series begins at the meeting on **6 August.** Led by the group co-ordinator, Pierre Hugo, it will review our understanding of a number of cosmological properties and concepts. See below for more details.

WHAT'S UP?

A star and a nebula Towards the south-west, the Eta Carinae nebula (NGC 3372) can be seen with the naked eye on a clear night. It is the brightest area along the southern Milky Way, between the Southern Cross and the False Cross. Binoculars show two large fans of lighted fuzziness separated by a dark gap. Reflecting its shape, this gap is the dark Keyhole nebula, a nebula within a nebula. In the smaller fan, also at a distance of about 7,500 light years, is the very bright star Eta Carinae, currently the seventh brightest star in the Carina constellation. One of the most massive and luminous systems in the galaxy, Eta Carinae is an unpredictable hypergiant irregular variable star. It is a so-called luminous blue variable, up to 10 million times brighter than the Sun.

Bright as it is now (magnitude 5), during its long periods of fluctuations over periods of decades, it has been much brighter. When Nicolas-Louis de Lacaille observed it from the Cape in the 1750s its magnitude was 2.3 and, in 1843, it reached -1 magnitude for a while, the second brightest star in the night sky. Material ejected during this episode has created an expanding cloud of gas and dust, the Homunculus nebula, which partly obscures the star. Like other hypergiant variables, its mass is so large it is unstable, experiencing periods of high mass loss, sometimes in violent outbursts, like the 1843 event. Such extreme mass loss episodes involve energies not far short of some supernovae. All its variable factors suggest that Eta Carinae is a young star. Not fully understood, it is located within a cluster of other massive stars and is thought to also be a binary star, orbiting round one of its massive neighbour.

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the meeting held on 16 July, Centre member, Johan Retief gave a very interesting talk on the 'History of the Voyager spacecraft: 1977-2018'. It was

very interesting to review the history of early space missions undertaken by NASA, which Johan summarised in order to clarify the times and context during which the Voyager craft were launched in 1977. During that year, a fortuitous alignment of planets enabled scientists to send these two craft to the outer planets of the solar system. During their missions, they took thousands of pioneering images of the four gas planets and some of their moons. These included many firsts including discovery of 22 new moons, four planetary ring systems and the presence of magnetospheres around Uranus and Neptune. The extensive detail supplied by Johan served to show how seemingly very basic spacecraft can still successfully function over 4 decades later. NASA is still in contact with both craft as they travel in interstellar space, well beyond the edge of the solar system.

Interest groups

Cosmology Those who attended the meeting on 2 July watched the final two episodes of the new DVD series: The Higgs boson and beyond by Dr Sean Carroll, Research Professor of physics at CalTech. These episodes were Lecture 11: 'Beyond the Standard Model of particle physics' and Lecture 12: 'Frontiers: Higgs in space'.

Astro-photography Those who attended the meeting on 9 July continued work on processing their own astro-images.

Other activities

Stargazing

14 July Cloudy skies meant that the scheduled public event, unfortunately, had to be cancelled. However, Bennie Kotze took an excellent image of the night sky (see below) from his garden later in the evening.

On **17 July**, committee members led an evening of stargazing for 14 youth leader trainees and their supervisors at the Volmoed Centre in the Hemel-and-Aarde valley. Before predicted cloud cover moved in, they were able to observe the waxing moon, planets (Venus, Jupiter and Saturn), three Galilean moons, constellations (Southern Cross, Scorpius) and other celestial objects (Omega Centauri, Jewel box, false cross), using the naked eye, binoculars and telescopes.

Moonwatch 27 July The weather was, again, not kind during the Moonwatch arranged to view the long full lunar eclipse. However, intermittent gaps in the clouds did enable the 30 or so people who came and went during the evening, to observe both the eclipse at different stages and very bright Mars which was, coincidentally, at its closest to Earth on the same day. Unfortunately, it was not possible to take the planned series of stage images of the eclipse. The sky to the south did remain clear for a long period, allowing for good views of the Southern Cross and its surrounds and telescopic observation of Omega Centauri, Jewel Box, Eat Carinae and the southern Pleaides. In addition to Mars, Venus, Jupiter and Saturn were also visible, at times, during the evening. The eclipse image below was also taken by Bennie.

Educational outreach
Hawston Secondary School Space Cadets No meetings took place during the school holidays
Lukhanyo Youth Club No meeting took place during the school holidays.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on **Monday 20 August** at the **Catholic Hall** starting at **19.00**. Centre member and past Centre chairman has stepped in to replace the scheduled speaker, who has had to cancel. John's talk will be on 'Our weird and wonderful universe' John states: "Put your thinking caps away for another day. Relax and enjoy sights of our weird and wonderful universe and the beauty of the night sky. The presentation will include some oddities in the solar system and then out to the stars, our galaxy and beyond." John has given several presentations on a variety of topics over the years, and this one promises to be equally interesting and visually impressive.

There is an entrance fee of R10 per person for members, R20 per person for non-members, and R10 for children, students and U3A members.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month at 19.00. The next meeting will take place on **6 August** at the **Catholic Hall**, starting at **19.00**. It is the start of a new series titled 'Natural philosophy: science for the non-scientist' which will be led by Pierre Hugo. Topics to be covered during the coming months include inertial space, particle physics and special relativity, alternative theories of gravity, the role of the structure of space on the electromagnetic, strong and weak forces, and the impact of these reviews on cosmological observations.

There is an entrance fee of R10 per person for members, R20 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 is on **13 August.** The topic will be image processing.

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 Organisers are progressing with work towards enabling learners to take and process images themselves.

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

FUTURE ACTIVITIES

Cederberg trip The 12-14 October trip to the Cederberg is fully booked. Please contact John Saunders at antares@hermanus.co.za with any queries.

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**. Details for the first few months are:

20 August	'Our weird and wonderful universe' Presenter: John Saunders, Centre member.
17 September	'Gravitational waves: the new frontier in astronomy' Presenter: Dr David Buckley, SAAO, Cape Town
22 October	'The Fermi paradox and its implications for extraterrestrial life' Presenter: Johan Retief, Centre member
19 November	'Table Mountains: geology and astronomy' Presenter: Jenny Morris, Centre member
10 December	Xmas party

ASTRONOMY EDUCATION CENTRE AND AMPHITHEATRE (AECA)

A decision by the Council of Overstrand Municipality on the planning application continues to be awaited. In the meantime, the Friends of the Observatory pledge fund continues to be an important source of funds to cover associated costs.

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, something which is still awaited.

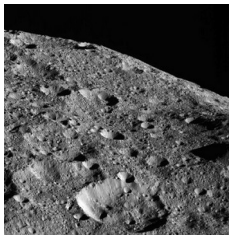
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer,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

NASA spacecraft gets breathtakingly close to dwarf planet 3 July: NASA's Dawn spacecraft has entered its nearest orbit ever to the dwarf planet Ceres, an icy body in the asteroid belt left over from the formation of the solar system, and is already turning up stunning results. The latest images sent back by the spacecraft were captured just 35 km above a site called Occator Crater. Before June, Dawn was orbiting hundreds of miles over the surface.



NASA's Dawn mission caught this view toward Ceres' horizon before lowering to an orbit just dozens of kilometres above the dwarf planet's surface NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

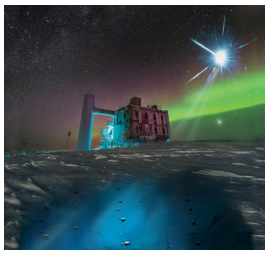
This bright region first stood out to astronomers when Dawn arrived at Ceres in 2015. While much of the dwarf planet is dark, the crater's centre has several strange reflective

spots that were easily visible from orbit. Scientists suspected that these formed as a mixture of salt and ice erupts onto the world's surface. Astronomers call this process cryovolcanism. These new observations help confirm that those bright spots are the indeed the result of cryovolcanism. The salty material is sodium carbonate, or soda ash. And astronomers say it likely welled up from a reservoir of briny water below the surface of Ceres and spewed onto the surface. Going forward, the new orbit should give Dawn a view of what, if any, geologic activity is happening on Ceres today. The world is about one-fourth the size of Earth's own moon. Dawn's new orbit is also one of the closest shaves of any NASA orbiter. The Lunar Prospector previously orbited the moon at just 32 km above the surface of that body, and a few others have dipped below that line but not survived.

The Dawn spacecraft was originally launched in 2007. It arrived at the asteroid Vesta in 2011, where it studied that body in depth and found features associated with ancient water flows. It also found evidence of a massive collision that fragmented Vesta into its present potato-like shape. In 2012, Dawn used its experimental ion engines to set a new course for Ceres, entering orbit in 2015. This made Dawn the first object to orbit two different bodies beyond the Earth-Moon system.

Dawn will stay in its new orbit for the duration of its mission, drawing out more and more details of Ceres. What was once believed to be the largest asteroid has now been revealed as a relict protoplanet that once had a since-frozen over ocean. In its new orbit, Dawn may also be able to detect if there are parts of an ancient ocean still left liquid under the surface, however unlikely. If that's the case, Dawn could be added to the list of places life might exist, or have existed, beyond Earth. By: John Wenz

A cosmic particle spewed from a distant galaxy strikes Earth 12 July: Four billion years ago, an immense galaxy with a black hole at its heart spewed forth a jet of particles at nearly the speed of light. One of those particles, a neutrino that is just a fraction of the size of a regular atom, traversed across the universe on a collision course for Earth, finally striking the ice sheet of Antarctica last September. Coincidentally, a neutrino detector planted by scientists within the ice recorded the neutrino's charged interaction with the ice, which resulted in a blue flash of light lasting just a moment.



This image combines a real photograph of the IceCube Lab in Antarctica with an artist's rendering of the project's sensors deep below the ice and the distant blazar from which a neutrino has been detected. IceCube/NSF

This detection marks the second time in history that scientists have pinpointed the origins of a neutrino from outside of our solar system. The only other confirmed source of neutrinos, other than the Sun, is a supernova that was recorded ini 1987. It is also the first time they have confirmed that neutrinos are created in the supermassive black holes at the centres of galaxies - a somewhat unexpected source.

Neutrinos are highly energetic particles that rarely ever interact with matter, passing through it as though it were not even there. Determining the type of cosmological events that create these particles is critical for understanding the nature of the universe. Physicists have a number of theories about what sort of astronomical events may create neutrinos, with some suggesting that blazars could be a source. Blazars are massive galaxies with black holes at their center, trying to suck in too much matter at once, causing jets of particles to be ejected outward at incredible speeds. Acting like the giant counterparts to terrestrial particle accelerators, blazar jets are believed to produce cosmic rays that can in turn create neutrinos.

This [detection] in particular is a chance of nature," says Darren Grant, a lead scientist of the team that first discovered the high-energy neutrino, as part of the neutrino detection project IceCube. "There's a blazar there that just happened to turn on at the right time and we happened to capture it. It's one of those eureka moments. You hope to experience those a few times in your career and this was one of them, where everything aligned."

On 22 September 2017, the neutrino reached the Antarctica ice sheet, passing by an ice crystal at just the right angle to cause a subatomic particle (called a muon) to be created from the interaction. The resulting blue flash was recorded by one of IceCube's 5,160 detectors, embedded within the ice. Grant was in the office when the detection occurred. This neutrino was about 300 million times more energetic than those that are emitted by the Sun.

Grant and his colleague briefly admired the excellent image depicting the trajectory of the muon, which provides basic information necessary to begin tracing back the neutrino's origin. However, they were not overly excited quite yet. His team observes about 10 to 20 high-energy neutrinos each year, but the right combination of events - in space, time and energy, for example - is required to precisely pinpoint the source of the neutrino. Such an alignment had eluded scientists so far. As Grant's team began their analysis, though, they began to narrow in on a region: an exceptionally bright blazar called TXS 0506+056.

Upon the detection, an automatic alert was sent to other astronomy teams around the world, which monitor various incoming cosmic signals, such as radio and gamma rays. A few days later a team of scientists using the MAGIC telescope in the Canary Islands responded with some exciting news: the arrival of the neutrino had coincided with a burst of gamma rays – which are extremely energetic photons – also coming from the direction of TXS 0506+056. Other teams analysing the region following the initial detection observed changes in X-ray emissions and radio signals too. Collectively, the data is a huge step forward for physicists in understanding blazars, and high-energy cosmological events in general.

This detection provides the first evidence that a blazar can produce the high-energy protons needed to generate neutrinos such as the one IceCube saw. Sources of high-energy protons also remain largely a mystery, so the identification of one such source is another big step forward for astronomers. "It's really quite convincing that we've unlocked one piece of that puzzle," says Grant.

Scientists are continuing to monitor TXS 0506+056, hoping to learn more about this colossal event. One team conducted a detailed analysis to determine how far away the blazar is from us, astounded to discover that it is a whopping four billion light years away.

While TXS 0506+056 was always considered a bright object in the sky, this luminosity at such a distance makes it one of the brightest objects in the universe. No doubt future studies of this powerful blazar will yield valuable insights into the most energetic events to occur in our universe. By: Michelle Parker

Rare 'equal mass' binary asteroid discovered near Earth 13 July: More than 18,000 near-Earth asteroids have been identified, and all of which are thought to be remnants of the solar system's formation. They each have their own unique structure and properties. However, despite their distinct variations, we still come across an oddball every once in awhile. On 26 June , two separate teams of scientists confirmed an exceptional 'equal mass' binary asteroid cruising past Earth - one of only four ever discovered.

Asteroid 2017 YE5 consists of two equal-size objects, each stretching roughly 900m in diameter, orbiting each other once every 20 to 24 hours. It is pretty common for large asteroids to link up with smaller ones, with about 15 percent of near-Earth asteroids over 200m being binary pairs. However, coming across a binary consisting of two similar-sized objects is much more rare. The asteroid's uncommon nature was hidden from researchers until very recently, though. It was first discovered in December 2017 by the Morocco Oukaimeden Sky Survey and, at the time, was believed to be a single near-Earth object. To investigate, researchers scheduled follow-up studies for 21 June when the asteroid was just 6 million km from Earth, the closest it would be for the next 170 years.

During its fly-by, NASA's Goldstone Solar System Radar (GSSR) in California detected something unexpected - two distinct mounds jutting out of its body. Because of its orientation in the sky, though, it was unclear if the asteroid was one abnormally shaped mass or two separate entities. With some time, the researchers were able to witness an orbital rotation that revealed a clear void between the objects. They shared their discovery with colleagues at Puerto Rico's Arecibo Observatory, who were already planning on observing the asteroid. To get a more comprehensive view of the potential duo, the Arecibo team collaborated with scientists at West Virginia's Green Bank Observatory (GBO). Together, they would study the asteroid using a bi-static radar configuration, in which radar signals are bounced off the asteroid by Arecibo and received by GBO. The technique enabled the observatories to view different areas of the asteroid simultaneously, leading each team to confirm that 2017 YE5 is, in fact, an equal mass binary asteroid.

Its dual nature was not the only strange attribute to come to light, either. During optical observations, researchers were able to estimate the asteroid's size based on the amount of visible light it emitted. However, radar imaging showed that the duo is darker in colour and reflects less sunlight than typical asteroids, making it larger than its optical brightness lets on. The research also revealed distinct differences in the objects' radar reflectivity, which has not been observed in previously studied binary asteroids. These variations suggest that the masses likely have different surface compositions, textures, or densities. The researchers plan to dig into the asteroid's radar and optical data to predict the densities of each component, which could give insight into their formations, structures, and compositions. By: Amber Jorgenson

In a rare feat, scientists anticipate and recover an incoming asteroid 13 July: Swarms of scientists search the skies for space oddities, but it is rare that they actually find one in the act of plunging to Earth. On 23 June, a group of international geoscientists discovered a meteorite in Botswana that had been dwelling in space just weeks earlier.

The fresh fragment broke off Asteroid 2018 LA as it plummeted to Earth on 2 June, turning into a fiery meteor and exploding as it entered the atmosphere.


Small meteorite recovered from the asteroid impact. Peter Jenniskens

The geoscientists spent five days combing the land beneath the meteor's impact area before finding the tiny meteorite - marking only the second time remnants from a predicted asteroid impact have been recovered. Since such freshly fallen meteorites are so uncommonly found, researchers now have the rare opportunity to study its properties and composition first-hand.

The Catalina Sky Survey in Tucson, a NASA funded Planetary Defence project that locates and tracks near-Earth objects, discovered the asteroid only eight hours before it made impact with Earth. Any potential threat was quickly dismissed, though, when telescope observations deemed it to be just 2m in diameter, making it small enough to safely break apart in Earth's atmosphere. Exactly where the asteroid would strike was still unknown. Researchers were able to loosely estimate impact sites above New Guinea, Southern Africa and the Indian Ocean, but nothing was certain. However, speculation was squashed when a quick, luminous flash in the low sky took multiple Botswana residents and area surveillance cameras by surprise. The unexpected spark turned out to be the blazing asteroid, entering the atmosphere at 17 km per second.

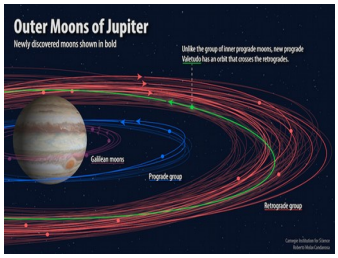
Upon impact, the meteor fragmented into numerous pieces and scattered over the vast area below. To find the resulting meteorites, research scientist Peter Jenniskens of California's SETI Institute used sky survey data and video footage to calculate the landing area and pinpoint its altitude and position in the sky. After five days of searching the calculated region, geologist Lesedi Seitshiro finally came across the surviving meteorite in Botswana's Central Kalahari Game Reserve.

Although the meteorite is small in size, its significance is anything but. There were only two prior instances where asteroids were discovered hours before hitting Earth - one being Asteroid 2008 TC3, which stretched 4m and entered the atmosphere above Northern Sudan in 2008, and the other being Asteroid 2014 AA, which crashed over the Atlantic Ocean in 2014. Researchers were only able to locate meteorites from 2008 TC3, making this find just the second such occasion.

It may seem like the team has struck gold, but the search is far from over. Geoscientists will continue to hunt for additional meteorites, with hopes of learning more about the celestial objects that circle and sometimes plummet towards Earth. And since the Catalina Sky Survey discovered all three of the above asteroids, researchers can continue to tweak its detection methods and evaluate its success rate. By: Amber Jorgenson

Jupiter has twelve new moons — one is a bit of a problem child 17 July: Jupiter's family has really grown since Galileo first recorded its four largest moons in 1610. Today,

the International Astronomical Union (IAU) announced the discovery of 10 new moons orbiting Jupiter. Along with two found through the same research project but announced in June 2017, this brings the roster of Jupiter's known natural satellites to 79.



The orbits of the twelve newly discovered moons of Jupiter. Roberto Molar-Candanosa/Carnegie Institution for Science

One of these new moons turned out to be a bit of a rebel. Of the 12 latest moons to join Jupiter's family, it is a maverick whose odd orbit may give astronomers crucial insights to understanding how the moons of Jupiter came to be.

The discovery of these moons came from a totally different search for new solar system bodies. Astronomer Scott Sheppard of the Carnegie Institution for Science is on the hunt for Planet Nine, a hypothetical planet many astronomers think should exist in the distant reaches of the Solar System, beyond Pluto. He and his team have been photographing the skies with some of today's best telescope technology, hoping to catch sight of this mysterious ninth planet. In the spring of 2017, Jupiter happened to be in an area of sky the team wanted to search for Planet Nine. Sheppard, who is broadly interested in the formation of solar systems and has been involved in the discovery of 48 of Jupiter's known moons, realised this was the perfect opportunity to advance two separate research goals with the same telescope data.

The Blanco 4-metre telescope Sheppard was using is uniquely suited to spotting potential new moons both because the camera installed on it can photograph a huge area of sky at once and because it is particularly good at blocking stray light from bright objects nearby - say, Jupiter - that may wash out fainter ones. Once the Blanco telescope spotted previously unidentified objects near Jupiter, the research team used other telescopes to follow up on these moon candidates and confirm that they were orbiting Jupiter.One moon in particular caught the researchers' attention. "The most interesting find is this object we're calling Valetudo," Sheppard says. "It's like it's going down the highway in the wrong direction."

Of the 79 moons now known, most orbit in the same direction as other moons nearest them. The moons closer to Jupiter, including the four Galilean satellites, orbit Jupiter in the same direction as the planet's rotation - astronomers call this a prograde orbit. The outer moons move in the opposite direction - a retrograde orbit. Eleven of the twelve new moons follow these conventions, but Valetudo is the odd one out. Itis out where the outer, retrograde moons are, but it' is orbiting Jupiter in the prograde direction, driving into the oncoming traffic.

The curious find might shed light on how many of Jupiter's current moons were formed. Aside from the hulking Galilean moons that stretch thousands of miles in diameter, most of Jupiter's moons, including the new twelve, are between half a kilometre and a few tens of kilometres across. The outer moons are clustered in at least three groups based on

their distances from Jupiter and the angles of their orbits, and astronomers think these moons are fragments of three larger objects that were captured by Jupiter's gravity and later broken up by collisions - though whether that was with passing comets, rogue asteroids, or other moons is unclear.

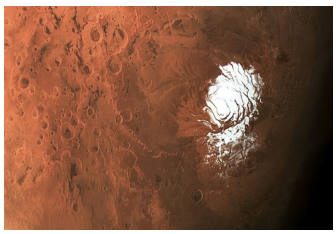
Because Valetudo's orbit crosses the orbits of some of the outer retrograde moons, it is possible that it suffered a head-on collision in the past. The research team thinks Valetudo could be a leftover chunk from a once-larger moon that rammed into another past Jovian satellite, creating the many smaller objects that exist today. To check whether this could have happened, the researchers are working on supercomputer simulations of these orbits to calculate how many times an object with Valetudo's orbit could have collided with the retrograde moons in the solar system's lifetime.

Finding lots of these small moons also tells us about conditions in the early solar system. When Jupiter and the other giant planets were forming, the solar system was a disk and gas and dust that surrounded the infant Sun. "The giant planets formed out of material that used to be in that region. They were like vacuums, they sucked up all that material and that created the planets," Sheppard explains. "We think these moons are the last remnants of the material that formed the giant planets."

The fact that these smaller moons exist today is evidence that any collisions that created them happened after this era of planet formation. If small moons like these were around when the solar system was still thick with gas and dust, drag forces would have slowed them down and caused them to fall into Jupiter, never to be seen again. Only in today's much emptier solar system, after the giant planets finished forming and clearing their surroundings of gas and dust, would small moons like these have been able to survive.

By: Erika K Carlson

Vast lake of liquid water discovered on Mars 25 July: Astronomers have discovered a large underground lake of liquid water lurking just below the surface of Mars. The find could end a more than century-long debate over whether or not the Red Planet still has liquid water.



Mars' south polar cap and Hellas Basin are visible in this image, taken with the European Space Agency's Mars Express orbiter. ESA/DLR/FU Berlin

The newfound lake stretches some 19 km from end-to-end, and was discovered using a radar instrument called MARSIS on board the European Space Agency's Mars Express spacecraft, which first reached Mars nearly 15 years ago. "This is just one small study area," says study author Roberto Orosei. "It is an exciting prospect to think there could be more of these underground pockets of water elsewhere, yet to be discovered."

Scientists found the lake by launching radar pulses from the orbiter to penetrate the surface and reflect back, revealing secrets from just below the surface. It was discovered as they surveyed the Planum Australe region near Mars' southern ice cap, which is made

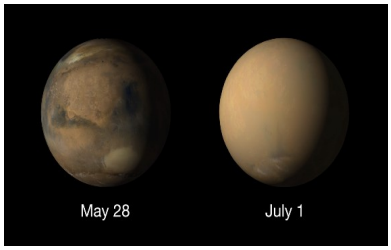
of water ice covered by frozen carbon dioxide. Between 2012 and 2015, the team obtained 29 radar samples and used them to map the subsurface nearly one mile deep in the area and about a dozen miles wide.

"We'd seen hints of interesting subsurface features for years, but we couldn't reproduce the result from orbit to orbit," says Andrea Cicchetti, also part of the MARSIS team. She says data resolution in the past was just too low. However, the team found a new way to operate the instrument that avoids processing data on the ageing spacecraft and instead sends observations to Earth, allowing a higher sampling rate.

The discovery is especially intriguing because underground lakes like this are also found near Earth's poles, particularly in Greenland and Antarctica. In recent years, scientists actually drilled deep beneath the Antarctic ice into one of these, the subglacial Lake Whillans, which had been cut off from the surface for millions of years. They found bacteria still living there in complete isolation. Scientists have also travelled deep underground into mines and found microorganisms related to ancient species that once lived in watery environments much closer to the surface. Such migrations raise the possibility of the same thing happening on Mars - as the water retreated, life moved deeper underground.

However, while the find is tantalising for astrobiologists eager to find alien life, it is also a bit of a tease. It will be decades before astronauts can visit the surface of Mars, and likely much longer before we can drill a mile beneath the dusty surface. So we may not see any Martian fishing expeditions in our lifetime. By: Eric Betz

Dust on Mars likely comes from massive volcanic deposit 25 July: Mars will remain engulfed in a colossal dust storm as it reaches opposition on 27 July. Astronomers can at least take solace in a long-awaited Martian mystery being solved - where all of this dust is coming from.



Dust storm first detected on 30 May 30. Has since expanded to cover nearly its entire surface. NASA/JPL-Caltech/MSSS

New research has revealed that the massive amounts of dust are tied to Mars' Medusae Fossae Formation (MFF), the largest explosive volcanic ash deposit in the solar system. Researchers from Johns Hopkins University found that Martian winds are gradually eroding the volcanic remnants, which cemented in place billions of years ago. The winds transform them into the fine dust particles that take over the planet during global and seasonal storms.

NASA's Mariner Spacecraft first discovered the 2 million square km formation in the 1960s, but its origins remained a mystery until recently. Researchers could tell from radar imaging that it had a strange composition, but they were not sure if water, ice, wind or a volcanic activity caused the peculiar structure. However, research used gravity data from

multiple Mars orbiters to measure the density of the formation. The results showed that it is only about two thirds as dense as your typical Martian surface and that it does not contain any ice - a composition that can only be explained by volcanic eruptions. Because of its porous nature, the MFF has fallen victim to Martian winds and significant erosion over the years. When remnants of powerful volcanic eruptions formed the structure over 3 billion years ago, it was about half the size of the United States. Now, it would cover just 20 percent of the U.S. So where did all of its sediment go?

To find out if it could be contributing to Mars' epic dust, the Johns Hopkins researchers compared the composition of surface dust to the composition of Medusae Fossae. Multiple Mars landers and rovers have collected dust samples from various parts of the planet. The scientists say they all contained an abundance of sulphur and chlorine – in a very specific ratio. Using data from NASA's 2001 Mars Odyssey spacecraft, the researchers found that the ratio of the volcanic region matched that of Mars' surface dust - suggesting that the volcanic deposit is the largest contributor to Martian dust. Based on its erosion rate, the scientists were able to calculate the amount of dust on Mars' surface. They found that there's enough to cover the entire planet in roughly (2 to 12 metres of sediment. The dust will keep building up as Medusae Fossae continues to erode.

The increasing amount of dust not only causes thicker storms, but it also contributes to their intensity. The dust absorbs some of Mars' solar radiation, which causes surface temperatures to decrease and atmospheric temperatures to increase. These temperature variations make winds stronger than usual, releasing even more dust that gusts across the surface during storms. These conditions might have created a powerful global dust storm during our prime time for viewing Mars in the night sky, but the unfortunate coincidence was not exactly a surprise. Global storms pop up every six to eight years or so, and it just so happened to interrupt Mars at its brightest this time around. By: Amber Jorgenson

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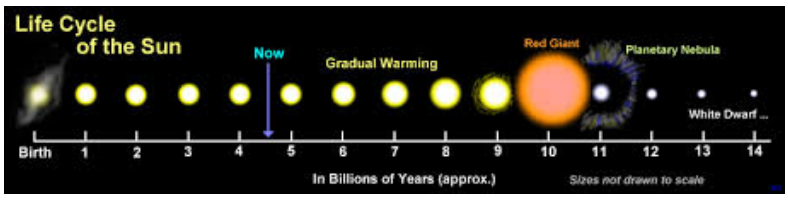
DID YOU KNOW?

The Sun Part 29: **Solar life cycle**



Solar life cycle

Formation The Sun formed about 4.567 billion years ago from the gravitational collapse of matter within part of a giant molecular cloud. This was possibly triggered by shockwaves from a nearby supernova. Evidence for this is the high abundance of heavy elements eg gold, uranium in the solar system. Particle impact initiated rotation of the mass, which resulted in most of the mass becoming concentrated at the centre, the rest flattening out into a disk that would become the solar system planets. Over time, gravity and pressure at the centre caused the central mass to became increasingly hot, hot enough to eventually initiate nuclear fusion. The Sun was born.

Main sequence The Sun is now roughly middle aged, and described as being about half way through its main sequence stage, the time in its life when it shines by converting

hydrogen to helium at its core. Every second, more than 4 million tonnes of matter are converted into energy within the core, producing solar radiation and neutrinos. So far, the Sun has converted around 100 times Earth's mass into energy, about 0.03% of its own total mass. It is currently about half way through the most stable part of its life, the 8-10 billion years in the main sequence.

Over time, the Sun is gradually becoming hotter because the helium atoms in the core occupy less volume than the hydrogen atoms they replace. The shrinking core also allows the outer layers of the Sun to move closer to the centre and experience a greater gravitational force according to the inverse square law. This stronger force increases pressure on the core, which is resisted by a gradual increase in the rate of fusion and a resultant increase in energy emission. This process speeds up as the core gradually becomes denser and the Sun is about 30% brighter now than it was in its distant past. Its brightness increases by about 1% every 100 million years.

Later life stages After about another 4.5 billion years, hydrogen supply in the core will become exhausted and hydrogen fusion will stop. At his point, the Sun will, by definition, leave the main sequence, causing large internal and external changes. Although core hydrogen is exhausted, the Sun will still have hydrogen reserves in layers surrounding the core. The core will heat up this shell until it is hot enough for the hydrogen to be fused into helium. Using this reserve has a price, however, as the energy source is not dense, and its utilisation initiates the process which will convert the Sun to a red giant. During this time, its outer layers will expand as the final available hydrogen is consumed and the core contracts and heats up. The colour change towards red is a consequence of the Sun's exterior cooling as the star expands. The red giant Sun will be sufficiently large to engulf Mercury, Venus and, perhaps, Earth. During that process, its luminosity will have nearly doubled. The red giant stage will last around 2 billion years.

The gradual conversion to a red giant involves various stages. Initially, as it begins burning its hydrogen reserves, the Sun will start to expand into the sub-giant phase and slowly double in size over about 0.5 billion years. Then it will expand more rapidly over another 0.5 billion years until over 200 times larger than today, and 2,000 times more luminous. Then the red-giant-branch (RGB) phase will begin. During a timespan of approximately 1 billion years, the Sun will lose around a third of its mass. After the RGB, it will have about 120 million years of active life left.

During that brief time, much will happen. The dense core, full of degenerate helium, will become increasingly hotter until it ignites violently in the so-called helium flash, during which 6% of the core (itself 40% of the solar mass) will be converted into carbon within minutes. Then the Sun will shrink to about 10 times its current size, and 50 times the luminosity, with a temperature a little lower than that of today.

Now in the red clump or horizontal branch (HB) phase, the Sun will become moderately larger and more luminous over about 100 million years as it continues to burn the remaining helium in the core and any remaining shell hydrogen. When core helium is exhausted, it will repeat the expansion which happened after hydrogen was exhausted as it resorts again to using shell reserves, except much faster and it will become even larger and more luminous. This is the asymptotic giant branch (AGB) phase.

After about 20 million years in the AGB, the Sun will become increasingly unstable as its fusion processes become progressively inefficient, undergoing rapid mass loss and thermal pulses that increase the size and luminosity for a few 100 years every 100,000 years or

so. Thermal pulses become larger each time, later pulses increasing luminosity to as much as 5,000 times current levels, and widening the radius of the dying Sun to over 1 AU. Four thermal pulses are predicted for the Sun before it completely loses its outer envelope and starts forming a planetary nebula. By the end of the AGB phase, the Sun will only be about half its current mass.

During the rapid planetary nebula stage, luminosity will stay largely constant, as the temperature increases, with the ejected half of the Sun's mass becoming ionised into the nebula as the exposed core reaches 30,000 K. The final naked core temp will be over 100,000 K. The planetary nebula will disperse in about 10,000 years and the remnant will cool to becomes a white dwarf. The cooling white dwarf will survive for trillions of years before fading into a black dwarf.

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

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